CRUISE REPORT

C - 107

ACADEMIC PROGRAM

Woods Hole - St. Albans - Lunenburg - Woods Hole

July 7, 1989 through August 25, 1989

SSV *Corwith Cramer*

Sea Education Association
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Shipboard Draft

PREFACE

Last summer I was asked during a public relations event for SEA to describe what was unique about SEA's Sea Semester program in relation to other academic experiences. The questioner had his doubts about the academic validity of the program and felt it could be enhanced by a more formal affiliation with an established college or university.

Taken a bit off guard by his stance, since I had no doubts concerning our program, it took me a while to collect my thoughts and I bought some time stating some of the more obvious and frequently stated opinions. First, I mentioned the sense of intimacy with the sea that we instill in our students. He said that was fine but there were other sea going programs that offered just as much intimacy, not to mention simply sailing around the world on a yacht. Second, I mentioned the responsibility that our students had for running both the ship and the scientific programs. He said that was fine too, but not very academic, and that the military also teaches responsibility. I did earn a few points when I said that we were one of very few undergraduate opportunities for a student to study oceanography at sea (the only one that really goes to sea since the others work along the coast!). I even brought up self reliance and self awareness, and he immediately countered with Outward Bound.

It was not until I got to one of the primary reasons that keeps me interested and motivated that I finally won the questioner over. In Sea Semester we teach the process of science. I know of no other undergraduate program that allows the student to work his or her way through the entire procedure. Yes, there are many opportunities for students to work with a professor or a graduate student on an existing research project, but the opportunity to do one's own literature search, to develop one's own hypothesis, to design the research plan to test it, to implement that plan, and finally, to formally report the results before a body of questioning peers is rarely available to the undergraduate except at SEA. I have never had a science major tell me on any of my Sea Semester cruises that he or she was experienced in the rigors of research. In fact, most students are quick to point out their lack of exposure. It is my firm belief that not only are we unique in our teaching of the scientific method, but that we do it very well and it is of value to both the science and non-science majors. It is simply critical in this day and age to understand how we learned what we think we know.

Certainly, one does not need a sea going program to teach the scientific method. But, added to the solid academic foundation in oceanography, the developed sense of intimacy with the sea, the increased self reliance, and dozens of other aspects of the program, the better understanding of the process of science adds to the unique mix that makes Sea Semester an outstanding program that readily stands on its own.

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INTRODUCTION

This cruise report provides a record of the academic activities conducted during the cruise C-107 of the SSV *Corwith Cramer*. The cruise was preceded by a rigorous six-week course on shore. The oceanographic research on the cruise was done entirely to accomplish individual projects designed during this period in Woods Hole. The research projects emphasized the application of theoretical concepts to the study of the oceans.

Overall, the students gained practical experience in biological, physical, chemical and geological oceanographic research in diverse regions of the northwestern Atlantic Ocean. Temperature, salinity, density, dissolved oxygen, phosphate, nitrate, silicate, and chlorophyll *a* analyses were carried out in shelf and slope waters. Plankton samples were taken along the entire cruise track. Demersal fish populations were assessed on Georges Bank, and sediment samples were collected within Bay D'Espoir, Newfoundland, Canada. Surface data on plastic and tar pollution were also collected along the entire cruise track.

ITINERARY

July 7, 1989	Depart Woods Hole, Massachusetts
July 25, 1989	Arrive/depart Grand Bank, Newfoundland, Canada
July 29, 1989	Arrive St. Albans, Newfoundland, Canada
July 30, 1989	Depart St. Albans, Newfoundland, Canada
August 5, 1989	Arrive Sable Island, Canada
August 6, 1989	Depart Sable Island, Canada
August 8, 1989	Arrive Lunenburg, Nova Scotia, Canada
August 10, 1989	Depart Lunenburg, Nova Scotia, Canada
August 19, 1989	Arrive Northeast Harbor, Maine
August 21, 1989	Depart Northeast Harbor, Maine
August 22, 1989	Arrive/depart Isles of Shoals, New Hampshire
August 25, 1989	Arrive Woods Hole, Massachusetts

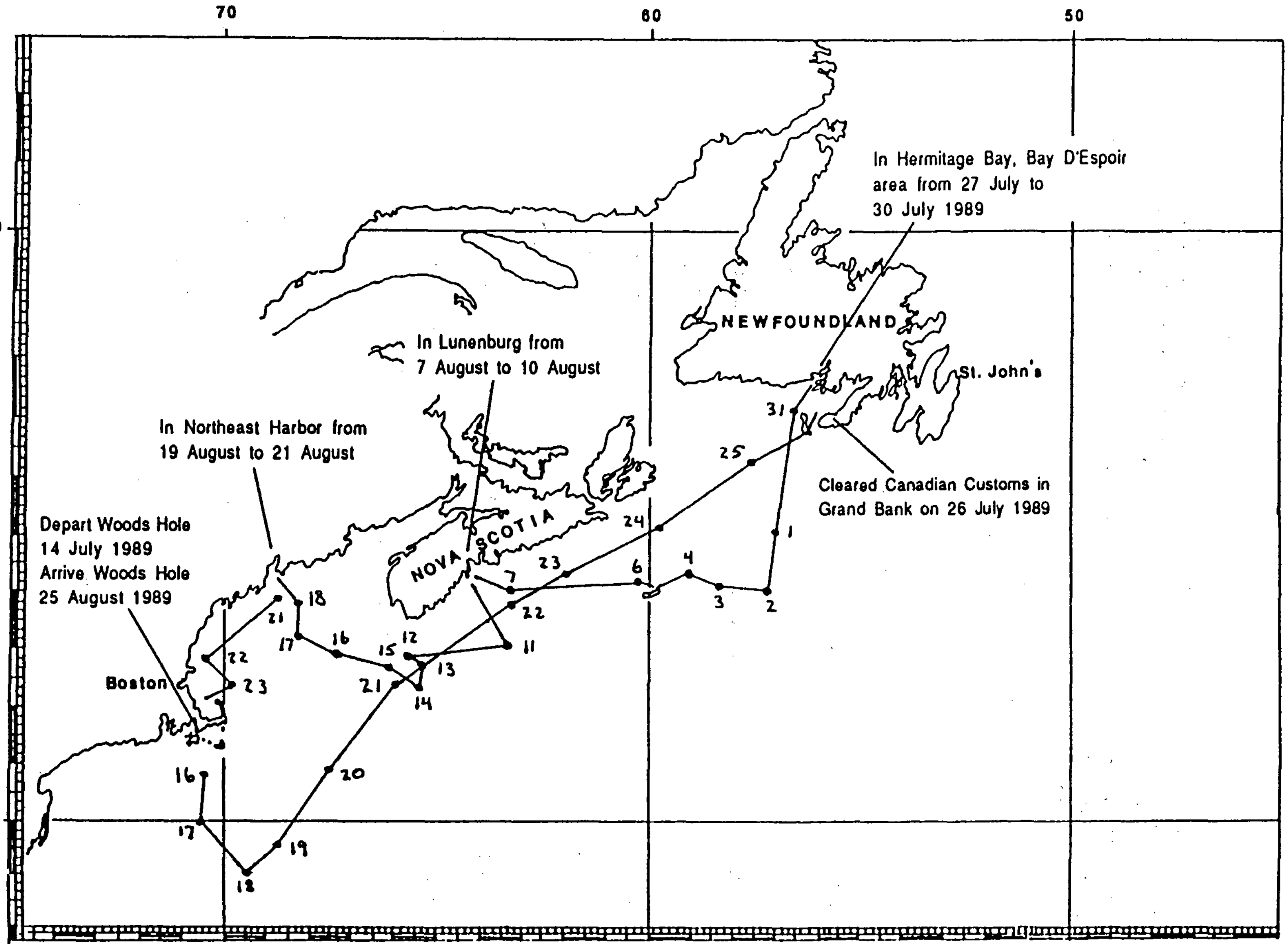


Figure 1 - Noon (1200 hours) positions of the SSV *Corwith Cramer* during Sea Education Association cruise C-107

SHIP'S COMPLEMENT ON SSV *CORWITH CRAMER* CRUISE C-107

<u>Nautical Staff</u>

Ron Harelstad - Master
Rich Johnson - Chief Mate
David Whitney - Second Mate
John Gryska - Third Mate
Trent Thornton - Engineer
Beccy Grundy - Steward

<u>Scientific Staff</u>

Clifford Low - Chief Scientist
Steve Hilger - Assistant Scientist
Adam Brunet - Assistant Scientist
Larry LeBlanc - Assistant Scientist

STUDENTS

Michael D. Bierie	Northern Arizona University	Biology
Andrew J. Black	Pennsylvania State University	Electrical Engineering
Rachel A. Brown	Emory University	Biology
Daniel M. Evans	Vanderbilt University	Philosophy
Mauricio Garces	Eckerd College	Marine Science
Andrew L. Gerard	Colgate University	Biology
Katherine C. Hewitt	Trinity College	Biology
Briony D. Jeffries	Colorado College	Biology
Karl E. Johnson	Cornell University	Social Science
Michael E. Loyd	St. Lawrence University	Undeclared
Carrie A. McCusker	Middlebury College	English
Daniel V. McFadden	Cornell University	Government
Mark V. Olcott	Albion College	Biology
David R. Perkins	Boston College	Psychology
Christian E. Rance	University of Pennsylvania	Electrical Engineering
Courtney E. Richmond	Swarthmore College	Biology
Lucinda D. Robb	Princeton University	Political Science
Michele R. Shipp	University of South Carolina	Anthropology
Charles R. Sontag	Beloit College	Biology
Charmaine M. Steigerwald	University of San Diego	Marine Biology

ACADEMIC PROGRAM

There were several aspects to the academic program aboard the SSV *Corwith Cramer*. First, a 24-hour science watch was maintained throughout the cruise by one of the assistant scientists and two or three students. During this time the students were instructed in the use of gear and the procedural aspects of physical, chemical, and biological oceanography. Responsibilities of science watch standers included maintenance of the science log, completion of scientific stations, routine observations of oceanographic and meteorological parameters, and the continuation of the scientific program in terms of analysis of samples and interpretation of data. In a very real sense, all the data that were collected, and the quality of these data, were a direct result of the efforts of the students. In addition, time was made available for work on an individual student's project. This was particularly true on the last leg of the cruise. The responsibilities of the students were gradually increased over the first half of the cruise so that, by the end of the third week, the students had control of the on-watch activities and answered directly to the Chief Scientist.

While at sea, students attended lectures Monday through Friday except when data collecting activities interfered. These lectures covered both practical and theoretical aspects of oceanography. A list of the topics covered follows. In addition, a collection of organisms was assembled and the students undertook an investigation of the ecology of a particular organism, for which they gave a formal written report.

During the last two weeks of the cruise, the students worked primarily on their individual research projects. These projects were defined by a written proposal ashore, and the bulk of ship's time during the first four weeks of the cruise was used to gather the data necessary for the completion of these projects. Students were required to give a formal oral presentation of their work and submit a final written report. The abstracts that follow later in this report are the result of the students' efforts.

C-107 was comprised of two courses in practical oceanography offered by Boston University through the Sea Education Association. Letter grades for each of the shipboard courses were determined on the basis of on-watch evaluations, a lab practical exam, a final exam, the organism report, and the research project. The research project was graded on the basis of overall effort, a project presentation, and the final written report.

TOPICS COVERED DURING LECTURE

Course Introduction
Hydrocast Demonstration
Collecting and Handling of Biological Samples
Otter Trawl Demonstration
Temperature Measurement at Sea
Theory and Operation of the Salinometer, Spectrophotometer, and Fluorometer
Fjords and Glacial Formations
Whale Evolution
Physiological Adaptations to Salinity
Currents - Gulf Stream, Labrador
Chemistry of Bioluminescence
Basics of Fish Design
Biochemical Cycling
Waves
The Intertidal Zone (Field trip on the Isles of Shoals)

ORGANISMS COVERED BY STUDENTS' REPORTS

Bryozoa	Chaetognaths
Nudibranchs	*Vellela vellela*
Mercenaria	*Physalia*
Octopus	Sea cucumber
Brittle Star	*Halobates micans*
Sea urchins	Sea squirts
Antedon	Lobster
Skates	Sea horses
File fish	Hatchet fish
Puffer fish	Shearwaters

Deep Water Renewal And Circulation In The Inner Basins OF Bay D'Espoir

Daniel McFadden

The purpose of this study was to examine the dynamics of the waters around Copper Head and Riches Island sills of Bay D'Espoir, and determine whether there was any renewal or circulation occurring during the summer. The inner basins of the bay have been observed to be well circulated and frequently renewed, although the actual mechanism was unknown. It has been suggested that tidal passage over a sill creates waves that induce turbulence which, in turn, result in the localized mixing of water layers beyond a sill (Stigebrandt, 1976). It was also suggested that such a localized mixing would create a step layered form in the temperature, salinity, and density profiles of the water column (Stigebrandt, 1979). It was hypothesized for this study that a tidally induced internal flow and mixing process would be taking place at the Copper Head and Riches Island sills if the step-layered form just described was observed in the water masses on the upcurrent side of each sill.

A CTD transect was made over each sill at flood tide. Water mass profiles were constructed from the temperature, salinity, and density data collected. The profiles demonstrated an inflow of 1°C, 32.4-32.6 ppt. water over Copper Head Sill. A step-layered form in the density profile was at least superficially present in the turbulence on Copper Head Sill. The Riches Island data indicated that its sill did not have a significant role in the renewal or circulation of the inner bay at that time. It was concluded that the Lampidoes Passage and the inner bay were being circulated and renewed primarily over Copper Head Sill.

Sediment Analysis On The Copper Head And Riches Island Sills In Bay D'Espoir, Newfoundland

Katherine Hewitt

This study analyzed the distribution of sediments in terms of grain size on the Copper Head and Riches Island sills. The kinds of sediments and how they are distributed in the bay are dependent on the available sediments and the hydrodynamic factors. Bay D'Espoir is a fjord created by a glacier and therefore the majority of the sediments are lithogenous. Saltwater inflow, freshwater outflow, internal waves and the wave energy are influential hydrodynamic factors.

The hypothesis of this study was that the distribution of sediments would reflect a high energy movement of water over the sills, a turbulent mixing process on the upcurrent side of the sills, and the lesser energy movement that would be found in the basins. It was expected that few but coarse sediments would be found on the tops of the sills, that coarse and well sorted sediments would be trapped on the inland side of the sills, and finer sediments would be found on the ocean side and in the basins. Using the Shipek sediment grab, a number of samples from the sides and tops of the sills were retrieved.

The hypothesized distribution was generally supported by the data. Well sorted, coarse sediments with varied volumes of silt and mud were retrieved inside Lampidoes Passage. Either no sediment, or very little, was collected from the tops of the sills. Both coarse and fine sediments were retrieved from the ocean sides of the sills.

Light Absorption Through The Freshwater Lens And Mixing Region Of Bay D'Espoir

Andrew J. Black

The purpose of this study was to quantify the penetration of light through the low salinity lens of Bay D'Espoir, Newfoundland. In addition to total radiation, the penetration of discrete wavelengths were measured and related to various physical and biological constituents in the water. Absorption coefficients for water samples from both the salt and fresh water layers were calculated. It was hypothesized that tannins, which are complex organic substances produced by plants and found in high concentration in the Bay D'Espoir, would have an effect on light transmission.

An irradiometer, equipped with color filters, was used to develop a table of extinction coefficients vs. depth. A CTD was used to identify the location of the freshwater lens boundary. A spectrophotometer was used to perform a full spectrum absorption analysis on the water samples.

The absorption data of the surface water closely resembled that of the tannin solution, while the deeper water data were closer to normal seawater. The spectrophotometer data seem to indicate that the surface waters absorb least in the red region. The irradiometer data indicate equal absorption of the different colors in the surface water, but these data may be suspect since the filters used were not very selective in terms of the frequencies of light that were transmitted.

The Distribution Of Phosphorus And Nitrogen In Bay D'Espoir, Newfoundland

Christian Rance

The surface concentration of phosphorus was found to increase from 0.07 µm/l at the head of Bay D'Espoir to 0.11 µm/l at a point just upstream from Copper Head sill. In Hermitage Bay the concentration was 0.32 µm/l . The increase in phosphorus was linked to the mixing processes that were taking place over Copper Head Sill. The vertical profile showed an increasing concentration of phosphate with increasing depth. The factors contributing to this trend were an overflow of dense bottom water over Copper Head Sill and phytoplankton productivity.

The surface nitrate concentration increased from 7.25 µm/l in Hermitage Bay to 11.72 µm/l at the head of the bay. The surface concentration near Copper Head Sill was seen to increase. This can be attributed to the mixing processes around Copper Head Sill. In most cases there was a decrease in the nitrate concentration below the surface. This was found to be directly related to phytoplankton productivity. Any deviation from this was thought to be related to the mixing at Copper Head Sill.

The Horizontal And Vertical Distribution Of Phytoplankton In The Bay D'Espoir

Michael D. Bierie

The abundance of phytoplankton is limited by various factors, including sunlight, nutrients, temperature, and grazers. These factors vary spatially in Bay D'Espoir. Horizontally, phytoplankton abundance was expected to be highest near the head of the bay because of the input of nutrients from freshwater sources. The abundance of phytoplankton was then expected to decrease moving towards the mouth of the bay. Vertically, the phytoplankton abundance was expected to be greatest at the surface and then decrease with depth following the availability of light.

At various stations in the Bay, samples of water collected by Niskin bottles were analyzed for chlorophyll *a* pigments using a Turner Fluorometer. The results showed a relatively constant horizontal distribution, with a vertical distribution of greatest abundance between depths of 7 and 20 meters.

Zooplankton Biomass And Distribution In Bay D'Espoir, Newfoundland

Carrie A. McCusker

This study examined the horizontal and vertical distribution of zooplankton in relation to salinity. The sample sites were chosen to correspond with different depths of the water column as well as to be in conjunction with CTD deployment sites.

Meter net tows, conducted at various depths in the bay, were correlated with CTD results to determine a relationship between salinity, depth and zooplankton biomass. Moving towards the head of the bay through Lampidoes Passage, the surface salinities decreased while the biomass increased. Deeper in the water column the salinities and the biomass remained more constant. Biomass was not found to vary significantly with depth.

Mixing Of Water Masses At The Shelf/Slope Frontal Regions Of The Northwest Atlantic

Karl E. Johnson

The purpose of this study was to determine the processes by which different water types mix in the continental shelf region of the northwestern Atlantic Ocean. The CTD was deployed over two transects of 4 stations each, one off Georges Bank and the other off the Scotian Shelf. By means of a T-S diagram, water masses were identified and a profile of each transect constructed. In order to account for a hypothesized abundance of nutrients near the shelf edge, a model for mixing was proposed and tested. It identified 4 types of water: surface shelf water, surface slope water, intermediate slope water, and deep slope water, and it showed deep slope water mixing upwards into surface water by means of internal waves (Miller, 1950). The observed data, however, identify 5 water masses. The data included a cold subsurface northern current, the source of which is probably the Labrador Current (McLellan, 1954). This cold water type, designated as type "D" in this study, occurs at shallow to intermediate depths alongside the shelf at both intersects, mixing upwards with surface waters and downward with slope water. D water is observed to be the most nutrient-rich water in the photic zone (top 100m), which is of great biological significance. Hence, it is suggested that future research focus on the role of D water - its interaction with surface and slope waters, and its function in transporting nutrients.

Nutrient Concentrations On The Shelf/Slope Frontal Regions Of The North Atlantic

Michelle Shipp

The hypothesis of this study was that the high concentrations of phosphate and silica found on the shelf/slope front would be due to the advection or localized upwelling of nutrient-rich water onto the front. CTD's and hydrocasts were done at two transects, one 130 nautical miles south east of Cape Cod (Georges Bank), and the second east of Sable Island. In the photic zone the highest nutrient levels were found in the cold northern subsurface water. The data showed no evidence of upwelling or advection.

A Study Of Phytoplankton Abundance Across The Shelf/Slope Front 39-44° North Latitude, 57-69° West Longitude

Briony Jefferies

It was hypothesized that abundance of phytoplankton on the shelf/slope front would be higher than that on the continental shelf or the continental slope. The data collected did not support this hypothesis.

Collection of the data started with locating a possible front through temperature readings. Two transects of the shelf/slope front were sampled. Four stations were tested across each transect, consisting of a hydrocast and a CTD station. Water samples from different depths were obtained with Niskin bottles. These samples were analyzed for chlorophyll *a* abundance, which directly relates to phytoplankton abundance. Phosphate and silicate concentrations were also measured for these waters.

CTD data showed deep water was not mixing with shelf water at the front. Mixing at the front did involve a cold, nutrient rich current from the northwest. The high concentrations of nutrients in this water directly relates to high chlorophyll *a* concentrations at depths above fifty meters in this study.

Zooplankton Population Distribution In The Shelf/Slope Frontal Region

Michael E. Loyd

The purpose of this study was to determine where zooplankton biomass was highest within two shelf/slope frontal regions of the western North Atlantic, and the factors that control biomass concentration in these regions. Eight stations were sampled where an oblique meter net tow, a hydrocast, and a CTD were deployed. Zooplankton density was estimated by water displacement and phytoplankton abundance was determined by using the fluorometer to measure chlorophyll *a* concentrations. The shelf/slope frontal region south of Georges Bank and the region over the shelf break south east of Sable Island were studied.

Highest concentrations of zoopklankton were found in surface shelf waters and cold northern sub-surface waters due to the high nutrient concentrations in these waters. Also, a steady increase of zooplankton density was seen crossing from slope to shelf waters onto Georges Bank as a result of the mixing of the shallow area. Lastly, there was no basis for a correlation between zooplankton density and phytoplankton abundance in these shelf/slope regions at the times studied.

Seaweed Phosphate Uptake And Biomass

Mauricio Garces

This study was based on the hypothesis that free floating strands of *Ascophyllum nodosum* are not as healthy as those strands that are still attached to the rocks in their normal habitat in the intertidal zone, and, as a result, will eventually die. The rate of phosphate uptake was used as a measure of the relative health of the plant samples, because phosphate is a necessary nutrient for plant growth and the concentration of phosphate is easy to measure aboard ship. It was assumed that the healthy plant samples would absorb phosphate faster than the unhealthy samples.

Ascophyllum samples were collected from the ocean surface along the cruise track and from the shore in Bay D'Espoir. The samples were incubated in nutrient-enriched water, and the phosphorus concentrations were measured before, during, and after incubation using normal spectrophotometric techniques. The results of the investigation were generally inconclusive. Insufficient replication of samples was a problem along with some difficulties in the incubation process. Several of the samples appeared to be releasing phosphate to the water as opposed to absorbing it. There was some indication of a decrease in phosphate uptake over time for all samples and a higher uptake rate for the shore samples than the offshore samples.

Observations On The Macrofauna On *Ascophyllum nodosum*

Rachel Brown

This study was designed to explore the various macrofauna found on *Ascophyllum nodosum* floating in waters overlying the Nova Scotia shelf, along the south coast of Newfoundland, and in the Gulf of Maine. The hypothesis tested was that distance from shore is a more important factor than salinity or temperature of seawater in determining the nature of the macrofaunal community found on *Ascophyllum nodosum*. Samples were collected by dip net at sea and by hand along the shore. Location, surface temperature, and surface salinity were taken at the time the sample was collected. The samples of seaweed were then washed with seawater and shaken over a sieve to gather any macrofauna present. The macrofauna were later identified and distance from shore was calculated in nautical miles.

Most species of macrofauna were found between 31-32.5 ppt salinity, and were evenly distributed through areas of different temperatures between 17 and 20.5 °C, depending on the species. Generally, the animal distribution varied according to distance from shore. *Sertularia pimila*, *Jaera marina*, and *Idotea baltica* were among the organisms only found between 0-10 nautical miles from the coast. *Hyperia gabla* was only found 60 nautical miles or more from the coast. The greatest variety of species was found between 35 and 50 nautical miles from shore.

Variations In The Timing Of Diel Vertical Migrations Of Marine Organisms As A Function Of Diet

Courtney Richmond

Variations in the timing of diel vertical migrations exist between the different species of vertically migrating organisms. Because the needs of a herbivorous and a carnivorous organism are different, type of diet may influence the specific migration pattern of the animal. The hypothesis of this investigation was that it is advantageous for the carnivorous migrating organisms to migrate to the surface later than the herbivorous organisms, because carnivorous organisms might be more concerned with the avoidance of visually oriented predators than their herbivorous counterparts. Using a combination of meter net tows of the surface waters, and deeper multi-meter net tows, this experiment traced the vertical distribution of calanoid copepods, which are herbivores, chaetognaths, which are carnivores, and midwater myctophid fishes, over a twelve hour period. The results of the study indicate that the chaetognaths, in fact, migrated to the surface waters earlier in the evening that did the calanoid copepods. The reason the migrations happened this way could be related to the fact that chaetognaths are transparent, making predator avoidance possibly less of a concern for these organisms.

The Abundance And Condition Factors Of Larval Fishes Across Different Hydrographic Regions In The Northwest Atlantic

Charmaine Steigerwald

The dependence of fish larvae on an abundant food source has been proven to be a primary factor in determining year class size and nutritive condition. This relationship, although affected by many biological and physical factors, can provide information about both the health of the larvae stock and the productivity of the surrounding water mass.

This study of relative abundance and fish "fatness" across hydrographic regions of Georges Bank, the continental shelf, the continental slope, the shelf/slope interface, and the Bay D'Espoir fjord, incorporated a morphological measurement concept known as the condition factor. This technique measured the width to length ratio of fish larvae to determine their relative healthiness, and presents a fairly accurate, easy, and efficient method of correlating size ratios among young larvae to the relative productivity of their immediate environment.

This project collected larval fish via meter net tows from several sites within each of the five water masses. The fish from these catches were counted, identified, separated by species, measured, and their condition factor values were determined. The results of the experimentation supported the hypothesis that fish larvae from Georges Bank occur in the greatest abundance and in the best nutritive condition, due to the overall high productivity in comparison to surrounding hydrographic regions.

A Comparison Of Endoparasitic Infestations Of Four Species Of Demersal Fish In The Northwest Atlantic

Andrew Gerard

Parasitism in marine fishes is common, and is generally the rule rather than the exception. It has been noted that the variety and extent of infestation is a function of five different characteristics of the host. These determinants include diet, life span, mobility, size and gregarious habits (Polyanski, Y.I. in Dogiel, et al., 1970). For this study, it was hypothesized that fish with differing feeding habits will support differing parasite assemblages.

Four different species of fish were obtained by two different methods. Longhorn sculpin (*Myoxocephalus octodecimspinosus*), red or squirrel hake (*Urophycis chuss*) and silver hake (*Merluccius billinearis*) were taken by otter trawl on Georges Bank, while cod (*Gadus mohua*) were taken by jigging with hand lines on Baccaro Bank. All species were found to contain many types of unidentified cysts. The cod were found to support an assemblage consisting of digenetic trematodes (40%), cestodes and nematodes (12% each) and unidentified cysts (36%). The silver hake were afflicted with nematodes (10%) and cysts (30%). The squirrel hake were infected most with nematodes (50%), while cestodes (20%), monogenetic trematodes (12%), digenetic trematodes (6%) and cysts (12%) made up the remainder. The sculpins were heavily infested with cestodes (66%) but also contained nematodes (13%), monogenetic flukes (5%), and cysts (16%).

Resource Partitioning In Three Species Of Demersal Fish On Georges Bank

Lucinda D. Robb

The purpose of this project was to determine whether resource partitioning occurred in similar demersal fish species on Georges Bank. It has been hypothesized that when sympatric species of fish overlap in their diet, specialization of predation occurs which allows the species to coexist in the same ecological niche. Food abundance, morphology and fish age have all been thought to influence resource partitioning. To test this hypothesis, the stomach contents of fifty-five fish were examined. The fifty-five fish represented the three species caught in significant numbers. These species were Silver Hake, Red Hake, and Longhorn Sculpin.

The results of analyzing the stomach contents showed clear evidence that some resource partitioning occurred, although the high amount of unidentified stomach contents was problematic. Amphipods were the only prey shared by all three species as a principal prey. The other principal prey of Silver Hake were fish, decapods and euphausids. The other principal prey of Red Hake were cumaceans, hermit crabs, isopods and mysids. The other principal prey of the Longhorn Sculpin were mantis shrimp, rock crabs, and isopods.

Very few of the fish species caught were juveniles, and the morphology of the fish was relatively similar, making for near optimum conditions to examine for resource partitioning. The high abundance of food at Georges Bank, which helps assure that many similar species of demersal fish will be caught, also lessens the incidence of resource partitioning that goes on. Further research on this subject might concentrate on looking for evidence of resource partitioning in areas less productive.

The Role Of Sensory Stimuli In Procellariiformes Foraging Behavior

Mark Olcott

The roles of olfactory and auditory stimuli in the foraging behavior of members of the seabird family Procellariiformes were studied to test the primary hypothesis that the birds would be attracted to olfactory stimulus (fish oil) and the secondary hypothesis that they would likewise be attracted to auditory stimuli of Procellariiformes feeding flocks. A sponge soaked in fish oil and towed behind the *Corwith Cramer* at various locations in the western North Atlantic served as an olfactory stimulus. As a visual control, seawater soaked sponges were also towed at various times. An audio tape of Procellariiformes feeding flocks was used as the auditory stimulus. Prestimulus bird counts revealed an average of 8.83 Procellariiformes present astern of the vessel for the ten minute periods tested. Control, olfactory, and auditory trials of identical time periods revealed mean bird counts of 11.67, 23,67, and 9.00, respectively. Data analysis revealed that Procellariiformes were attracted by olfactory stimuli, in support of the primary hypothesis. Data disputed the secondary hypothesis, however, indicating that Procellariiformes do not use the sound of other Procellariiformes feeding to aid in foraging.

Cetacean Feeding Patterns Or Whale Sightings Versus Prey Densities

Charles Sontag

The purpose of this experiment was to compare the location and number of sightings of cetaceans to the densities of zooplankton and to determine if the number of whale sightings increased as the density of zooplankton increased. Fifty-two meter net tows were taken along the cruise track. Some of the tows were taken as part of the normal daily routine and some were taken upon the sighting of a baleen whale. It was found that 72% of the whale encounters in which a meter net tow was taken occurred in the upper 27% of zooplankton densities recorded.

A Study Of The Nature, Quantity, And Distribution Of Marine Plastic In The Northwest Atlantic From Cape Cod To Newfoundland

Dan Evans

The primary purpose of this study was to develop some understanding of the mechanisms contributing to the presence of surface plastic in the Northwest Atlantic between Cape Cod and Newfoundland. Sources, types, and distributions of plastic gathered at sea were studied. Marine plastic was divided into two categories, raw and manufactured. Raw plastic was defined as the generic plastic from which consumer usable plastic is manufactured, and it is found in a pellet form. Manufactured plastic is the plastic that we use in our everyday lives, be it garbage bags, fishing line, or chemical containers.

Based on the findings that pellets found off the eastern coasts of the United States and Canada do not reflect significant local sources (Gregory, 1983) and that the Gulf Stream would act as the foremost supplier of pellets to slope water via warm core rings (Wilber, 1987), the following hypotheses were tested: 1) Higher concentrations of raw plastic would be found in slope water than shelf water. 2) Manufactured plastic would be found in higher concentrations than raw plastic in shelf water. 3) A warm core ring would have a higher concentration of plastic than either shelf or slope water. It was also hypothesized that there would be a general increase in the concentrations of plastic along the cruise track since those reported in 1987 for the same region (Wilber, 1987), due to the continued input of plastic into the sea and the long residence time of plastic in the ocean.

The plastic was gathered with a neuston net that had a mesh size of 333 micrometers. Twenty-nine stations were conducted, surveying both shelf and slope water. Each station involved two tows of approximately one nautical mile.

The concentration of pellets in the slope water tows was found to be higher than in the shelf water tows. Manufactured plastic was found to be more abundant in shelf water than raw plastic. Georges Bank had the highest overall concentrations of plastic. Finally, there did appear to be a general increase in plastic concentration on this cruise track since 1987.

The Distribution Of Pelagic Tar Northwest Of The Gulf Stream

Dave Perkins

This study was designed to assess the amount of pollution by pelagic tar in the North American shelf waters northwest of the Gulf Stream. Since the early 1970's there has been much concern over the presence of tar floating in the oceans. The origin of this weathered form of petroleum has been linked to the normal operating procedures of tankers carrying oil. Studies assessing the extent of the problem concluded that there was a significant rise in pollution by oil in the North Atlantic during the 1970's. Most of this increase was seen in the Sargasso Sea while the distribution of tar remained relatively constant north of the Gulf Stream. The lowest mean concentration of tar collected by an SEA cruise between 1977 and 1981 was 0.15mg/m^2.

Regulations aimed at reducing the amount of pollution by tankers were introduced during the early part of this decade by the U.S. government and international governing bodies. A decrease in tar concentration as compared with previous SEA cruises was expected as a direct result of shipping regulation. Tar collected from fifty-four neuston tows yielded a mean concentration of 0.14mg/m^2. The results of this study showed no statistically significant decrease in the presence of tar in shelf waters north of the Gulf Stream.

BATHYTHERMOGRAPHS

Date	Time	BT #	N. Latitude	W. Longitude
Jul 16 89	0742	EBT 001	40° 54'	70° 23'
Jul 16 89	1410	EBT 002	40° 46'	70° 31'
Jul 16 89	1650	EBT 003	40° 40'	70° 42'
Jul 16 89	2025	EBT 004	40° 34'	70° 47'
Jul 16 89	2145	EBT 005	40° 23'	70° 44'
Jul 17 89	0004	EBT 006	40° 10'	70° 37'
Jul 18 89	0719	EBT 007	39° 12'	69° 30'
Jul 19 89	0815	EBT 008	39° 20'	69° 03'
Jul 19 89	0921	EBT 009	39° 26'	68° 53'
Jul 19 89	0955	EBT 010	39° 30'	68° 49'
Jul 19 89	1120	EBT 011	39° 34'	68° 44'
Jul 19 89	1300	EBT 012	39° 39'	68° 39'
Jul 19 89	1540	EBT 013	39° 49'	68° 35'
Jul 19 89	2140	EBT 014	40° 06'	68° 17'
Jul 19 89	2240	EBT 015	40° 11'	68° 09'
Jul 20 89	1400	EBT 016	41° 00'	67° 10'
Jul 20 89	1810	EBT 018	41° 04'	66° 57'
Jul 20 89	2135	EBT 019	41° 19'	66° 44'
Jul 20 89	2330	EBT 020	41° 32'	66° 32'
Jul 21 89	0130	EBT 021	41° 40'	66° 22'
Jul 21 89	0330	EBT 022	41° 50'	66° 06'
Jul 21 89	0530	EBT 023	41° 58'	65° 52'
Jul 21 89	0805	EBT 024	42° 07'	65° 47'
Jul 21 89	0945	EBT 025	42° 14'	65° 51'
Jul 21 89	1035	EBT 026	42° 18'	65° 54'
Jul 21 89	1430	EBT 027	42° 40'	65° 51'
Jul 23 89	0940	EBT 029	44° 16'	62° 12'
Jul 25 89	1600	MBT 030	46° 35'	57° 21'
Jul 25 89	1745	MBT 031	46° 37'	57° 02'
Aug 1 89	2100	MBT 032	44° 37'	56° 53'
Aug 2 89	0315	MBT 033	44° 29'	56° 48'

CTD STATIONS

Date	Time	Station #	N. Latitude	W. Longitude
Jul 19 89	0217	009	39° 06'	69° 23'
Jul 19 89	1645	012	39° 49'	68° 35'
Jul 19 89	2318	015	40° 12'	68° 07'
Jul 20 89	0815	019	40° 42'	67° 36'
Jul 27 89	0717	041	47° 34'	56° 12'
Jul 27 89	0929	043	47° 42'	56° 08'
Jul 27 89	1320	045	47° 41'	56° 02'
Jul 27 89	1533	047	47° 42'	56° 02'
Jul 27 89	1550	048	47° 43'	56° 02'
Jul 27 89	1557	049	47° 43'	56° 02'
Jul 27 89	1605	050	47° 43'	56° 02'
Jul 27 89	1614	051	47° 43'	56° 02'
Jul 27 89	1628	052	47° 44'	56° 01'
Jul 27 89	1638	053	47° 44'	56° 01'
Jul 28 89	0930	062	47° 45'	56° 00'
Jul 28 89	1206	065	47° 48'	55° 51'
Jul 28 89	1217	066	47° 46'	55° 52'
Jul 28 89	1223	067	47° 47'	55° 52'
Jul 28 89	1229	068	47° 47'	55° 51'
Jul 28 89	1530	076	47° 49'	55° 51'
Jul 30 89	0727	078	47° 55'	55° 49'
Aug 2 89	1637	090	43° 37'	57° 38'
Aug 2 89	2153	093	43° 49'	57° 52'
Aug 3 89	0445	096	44° 02'	58° 04'
Aug 3 89	1936	099	44° 14'	58° 14'
Aug 14 89	1422	119	42° 16'	65° 39'
Aug 14 89	1504	120	42° 15'	65° 41'
Aug 14 89	1538	121	42° 14'	65° 43'
Aug 14 89	1611	122	42° 13'	65° 45'
Aug 14 89	1642	123	42° 11'	65° 47'
Aug 14 89	1711	124	42° 10'	65° 50'
Aug 14 89	1750	125	42° 09'	65° 51'
Aug 14 89	1819	126	42° 08'	65° 43'
Aug 14 89	1848	127	42° 07'	65° 56'
Aug 14 89	1937	128	42° 05'	65° 58'
Aug 14 89	2130	129	42° 03'	66° 00'
Aug 15 89	1812	133	42° 48'	65° 39'
Aug 16 89	1455	135	43° 05'	67° 33'
Aug 16 89	1838	136	42° 58'	67° 25'

HYDROCAST STATIONS

Date	Time	Station #	N. Latitude	W. Longitude
Jul 19 89	0320	010	39° 06'	69° 22'
Jul 19 89	1745	013	39° 50'	68° 34'
Jul 20 89	2355	016	40° 12'	68° 07'
Jul 20 89	0830	020	40° 42'	67° 36'
Jul 27 89	0743	042	47° 35'	56° 11'
Jul 27 89	1405	046	47° 42'	56° 03'
Jul 28 89	1046	064	47° 45'	56° 00'
Jul 28 89	1454	075	47° 47'	55° 51'
Jul 29 89	0908	080	47° 55'	55° 49'
Jul 29 89	1006	081	47° 50'	55° 50'
Aug 2 89	1814	091	43° 37'	57° 39'
Aug 2 89	2245	094	43° 48'	57° 52'
Aug 3 89	0615	097	44° 02'	58° 06'
Aug 3 89	2120	100	44° 15'	58° 16'
Aug 15 89	1825	134	42° 49'	65° 40'

NEUSTON TOW STATIONS

Date	Time	Station #		N. Latitude	W. Longitude
Jul 16 89	1204	001	a	40° 48'	70° 25'
Jul 16 89	1244	001	b	40° 48'	70° 25'
Jul 17 89	0055	002	a	40° 02'	70° 38'
Jul 17 89	0125	002	b	40° 02'	70° 38'
Jul 19 89	1208	011	a	39° 37'	68° 40'
Jul 19 89	1242	011	b	39° 37'	68° 40'
Jul 20 89	0154	018	a	40° 13'	68° 06'
Jul 20 89	0226	018	b	40° 13'	68° 06'
Jul 20 89	1235	022	a	40° 57'	67° 19'
Jul 20 89	1300	022	b	40° 57'	67° 19'
Jul 21 89	0000	025	a	41° 36'	66° 29'
Jul 21 89	0030	025	b	41° 36'	66° 29'
Jul 21 89	1216	026	a	42° 27'	65° 55'
Jul 21 89	1256	026	b	42° 27'	65° 55'
Jul 22 89	0005	028	a	43° 07'	64° 46'
Jul 22 89	0044	028	b	43° 07'	64° 46'
Jul 22 89	1200	029	a	43° 48'	63° 12'
Jul 22 89	1238	029	b	43° 48'	63° 12'
Jul 23 89	0000	031	a	43° 50'	62° 23'
Jul 23 89	0037	031	b	43° 50'	62° 23'
Jul 23 89	1200	032	a	44° 19'	61° 58'
Jul 23 89	1230	032	b	44° 19'	61° 58'
Jul 24 89	0010	034	a	44° 29'	61° 07'
Jul 24 89	0035	034	b	44° 29'	61° 07'
Jul 24 89	1152	036	a	45° 05'	59° 48'
Jul 24 89	1223	036	b	45° 05'	59° 48'
Jul 15 89	0023	038	a	45° 25'	58° 39'

NEUSTON TOW STATIONS - Continued

Date	Time	Station #		N. Latitude	W. Longitude
Jul 15 89	0052	038	b	45° 25'	58° 39'
Jul 25 89	1157	039	a	46° 17'	57° 37'
Jul 25 89	1230	039	b	46° 17'	57° 37'
Jul 27 89	0005	040	a	47° 24'	56° 10'
Jul 27 89	0040	040	b	47° 24'	56° 10'
Jul 31 89	1200	083	a	47° 06'	56° 34'
Jul 31 89	1228	083	b	47° 06'	56° 34'
Aug 1 89	0018	085	a	46° 04'	56° 52'
Aug 1 89	0041	085	b	46° 04'	56° 52'
Aug 1 89	1200	086	a	44° 57'	56° 52'
Aug 1 89	1230	086	b	44° 57'	56° 52'
Aug 2 89	1122	089	a	43° 58'	57° 15'
Aug 2 89	1204	089	b	43° 58'	57° 15'
Aug 11 89	0009	104	a	43° 29'	63° 25'
Aug 11 89	055	104	b	43° 29'	63° 25'
Aug 11 89	1214	106	a	43° 09'	63° 23'
Aug 11 89	1315	106	b	43° 09'	63° 23'
Aug 12 89	0000	108	a	42° 41'	63° 30'
Aug 12 89	0115	108	b	42° 41'	63° 30'
Aug 12 89	1200	111	a	42° 49'	64° 34'
Aug 12 89	1225	111	b	42° 49'	64° 34'
Aug 12 89	2358	113	a	42° 54'	65° 24'
Aug 13 89	0030	113	b	42° 54'	65° 24'
Aug 13 89	1200	115	a	42° 47'	65° 30'
Aug 13 89	1236	115	b	42° 47'	65° 30'
Aug 14 89	0000	117	a	42° 49'	65° 24'
Aug 14 89	1135	117	b	42° 49'	65° 24'
Aug 15 89	0002	130	a	42° 10'	65° 57'
Aug 15 89	0031	130	b	42° 10'	65° 57'
Aug 17 89	0010	137	a	43° 05'	67° 29'
Aug 17 89	0112	137	b	43° 05'	67° 29'

OTTER TRAWL STATIONS

Date	Time	Station #		N. Latitude	W. Longitude
Jul 20 89	1500	023	a	41° 02'	67° 04'
Jul 20 89	1530	023	b	41° 02'	67° 04'

ZOOPLANKTON STATIONS

Date	Time	Station #	N. Latitude	W. Longitude	
Jul 18 89	1155	003	39° 02'	69° 22'	
Jul 18 89	1400	004	39° 01'	69° 24'	
Jul 18 89	1715	005	39° 01'	69° 25'	
Jul 18 89	1941	006	39° 01'	69° 28'	
Jul 18 89	2120	007	39° 02'	69° 29'	
Jul 19 89	0003	008	39° 03'	69° 22'	
Jul 19 89	1910	014	39° 52'	68° 32'	
Jul 20 89	0107	017	40° 12'	68° 07'	
Jul 20 89	0900	021	40° 42'	67° 37'	
Jul 20 89	1940	024	41° 10'	66° 52'	
Jul 21 89	1739	027	42° 41'	65° 28'	
Jul 22 89	1305	030	43° 50'	63° 12'	
Jul 23 89	0100	033	44° 20'	61° 57'	
Jul 24 89	0820	035	44° 54'	60° 16'	
Jul 24 89	1308	037	45° 06'	59° 43'	
Jul 27 89	1000	044	47° 43' —	56° 08'	019
Jul 28 89		061	47° 45' —	56° 00'	020
Jul 28 89	1540	077	47° 49' —	55° 50'	021
Jul 29 89	0740	079	47° 53' —	55° 49'	
Jul 30 89	1902	082	47° 33' —	56° 01'	018
Jul 31 89	1334	084	47° 00'	56° 36'	
Aug 1 89	1315	087	44° 51'	57° 02'	
Aug 1 89	1820	088	44° 41'	56° 53'	
Aug 2 89	1847	092	43° 37'	57° 39'	
Aug 3 89	0013	095	43° 48'	57° 54'	
Aug 3 89	0755	098	44° 00'	58° 07'	
Aug 3 89	2138	101	44° 15'	58° 16'	
Aug 4 89	0755	102	44° 18'	58° 42'	
Aug 4 89	1149	103	44° 18'	59° 03'	
Aug 11 89	0242	105	43° 31'	63° 29'	
Aug 11 89	1404	107	43° 13'	63° 25'	
Aug 15 89	1018	107	42° 39'	66° 04'	
Aug 12 89	0147	109	42° 43'	63° 35'	
Aug 12 89	0837	110	42° 55'	64° 43'	
Aug 12 89	1324	112	42° 50'	64° 35'	
Aug 13 89	0127	114	42° 54'	65° 28'	
Aug 13 89	1348	116	42° 44'	65° 34'	
Aug 14 89	0126	118	42° 49'	65° 29'	
Aug 15 89	0158	131	42° 14'	65° 57'	
Aug 15 89	1010	132	42° 40'	66° 04'	
Aug 17 89	0223	138	43° 04'	67° 31'	
Aug 17 89	1204	139	43° 17'	68° 18'	
Aug 17 89	1933	140	43° 22'	68° 46'	

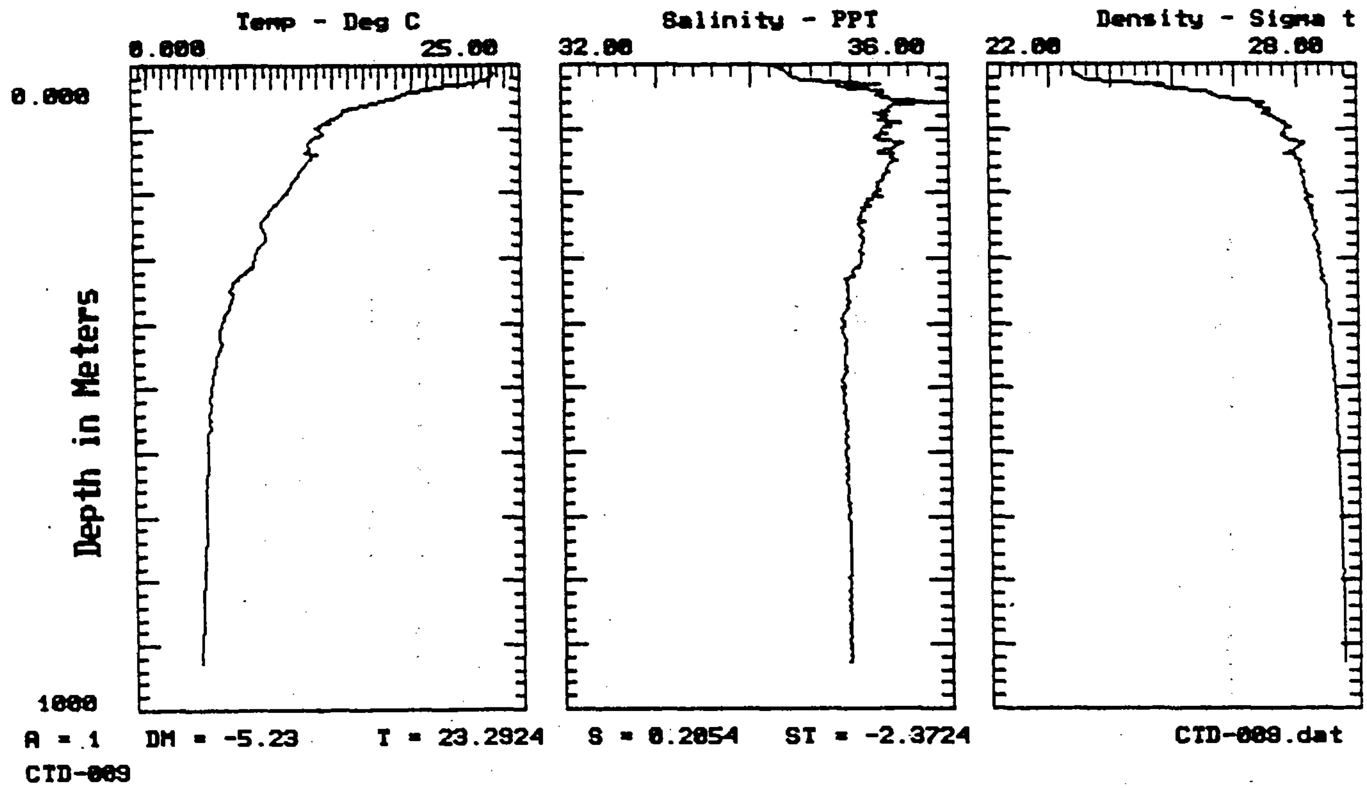
SHIPEK GRAB STATIONS

Date	Time	Station #	N. Latitude	W. Longitude
Jul 27 89	1654	054	47° 44'	56° 01'
Jul 27 89	1715	055	47° 44'	56° 01'
Jul 27 89	1731	056	47° 43'	56° 02'
Jul 27 89	1754	057	47° 43'	56° 02'
Jul 27 89	1755	058	47° 43'	56° 02'
Jul 27 89	1813	059	47° 43'	56° 02'
Jul 27 89	1822	060	47° 42'	56° 02'
Jul 28 89	0952	063	47° 45'	55° 56'
Jul 28 89	1319	069	47° 46'	55° 51'
Jul 28 89	1342	070	47° 46'	55° 51'
Jul 28 89	1354	071	47° 46'	55° 51'
Jul 28 89	1408	072	47° 46'	55° 51'
Jul 28 89	1408	074	47° 46'	55° 51'

NOON AND MIDNIGHT POSITIONS

DATE	TIME	LAT	LONG
7/14/89	1200	WOODS HOLE, MA	
7/15/89	0000	TARPAULIN COVE, MA	
7/15/89	1200	TARPAULIN COVE, MA	
7/16/89	0000	41° 04'	70° 44'
7/16/89	1200	40° 49'	70° 25'
7/17/89	0000	40° 10'	70° 37'
7/17/89	1200	40° 00'	70° 30'
7/18/89	0000	39° 20'	69° 34'
7/18/89	1200	39° 01'	69° 22'
7/19/89	0000	39° 03'	69° 22'
7/19/89	1200	39° 37'	68° 41'
7/20/89	0000	40° 12'	68° 06'
7/20/89	1200	40° 54'	67° 23'
7/21/89	0000	41° 36'	66° 29'
7/21/89	1200	42° 25'	65° 55'
7/22/89	0000	43° 07'	64° 46'
7/22/89	1200	43° 48'	63° 12'
7/23/89	0000	43° 50'	62° 23'
7/23/89	1200	44° 19'	61° 58'
7/24/89	0000	44° 29'	61° 07'
7/24/89	1200	45° 06'	59° 47'
7/25/89	0000	45° 24'	58° 40'
7/25/89	1200	46° 19'	57° 38'
7/26/89	0000	46° 54'	56° 09'
7/26/89	1200	GRAND BANK, CANADA	
7/27/89	0000	47° 24'	56° 10'
7/27/89	1200	47° 41'	56° 05'
7/28/89	0000	POMLEY COVE, BAY D'ESPOIR, CANADA	
7/28/89	1200	47° 48'	55° 51'
7/29/89	0000	SWANGER COVE, BAY D'ESPOIR, CANADA	
7/29/89	1200	ST. ALBANS, CANADA	
7/30/89	0000	ST. ALBANS, CANADA	
7/30/89	1200	47° 38'	55° 53'
7/31/89	0000	47° 33'	56° 15'
7/31/89	1200	47° 06'	56° 34'
8/01/89	0000	46° 04'	56° 52'
8/01/89	1200	44° 54'	57° 02'
8/02/89	0000	44° 33'	56° 51'
8/02/89	1200	43° 57'	57° 16'
8/03/89	0000	43° 48'	57° 54'
8/03/89	1200	44° 07'	58° 28'
8/04/89	0000	44° 16'	58° 17'
8/04/89	1200	44° 18'	59° 03'

DATE	TIME	LAT	LONG
8/05/89	0000	43° 57'	60 00'
8/05/89	1200	SABLE ISLAND, CANADA	
8/06/89	0000	SABLE ISLAND, CANADA	
8/06/89	1200	44° 12'	60 14'
8/07/89	0000	44° 10'	61 46'
8/07/89	1200	44° 03'	63 16'
8/08/89	0000	LUNENBURG, CANADA	
8/08/89	1200	LUNENBURG, CANADA	
8/09/89	0000	LUNENBURG, CANADA	
8/09/89	1200	LUNENBURG, CANADA	
8/10/89	0000	LUNENBURG, CANADA	
8/10/89	1200	44° 16'	64 08'
8/11/89	0000	43° 29'	63 28'
8/11/89	1200	43° 06'	63 17'
8/12/89	0000	42° 41'	63 30'
8/12/89	1200	42° 51'	65 35'
8/13/89	0000	42° 45'	65 34'
8/13/89	1200	42° 47'	65 30'
8/14/89	0000	42° 49'	65 24'
8/14/89	1200	42° 22'	65 24'
8/14/89	1200	42° 22'	65 24'
8/15/89	0000	42° 10'	65 57'
8/15/89	1200	42° 42'	66 02'
8/16/89	0000	42° 52'	66 18'
8/16/89	1200	42° 55'	67 23'
8/17/89	0000	43° 06'	67 25'
8/17/89	1200	43° 17'	68 18'
8/18/89	0000	43° 34'	68 40'
8/18/89	1200	43° 52'	68 15'
8/19/89	0000	44° 08'	68 12'
8/19/89	1200	NORTHEAST HARBOR, ME	
8/20/89	0000	NORTHEAST HARBOR, ME	
8/20/89	1200	NORTHEAST HARBOR, ME	
8/21/89	0000	NORTHEAST HARBOR, ME	
8/21/89	1200	43° 54'	68 39'
8/22/89	0000	43° 13'	69 53'
8/22/89	1200	ISLES OF SHOALS, NH	
8/23/89	0000	42° 45'	70 31'
8/23/89	1200	42° 23'	70 21'
8/24/89	0000	41° 56'	70 28'
8/24/89	1200	TARPAULIN COVE, MA	
8/25/89	0000	TARPAULIN COVE, MA	
8/25/89	0800	WOODS HOLE, MA	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Salinity - PPT
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Density - Sigma t
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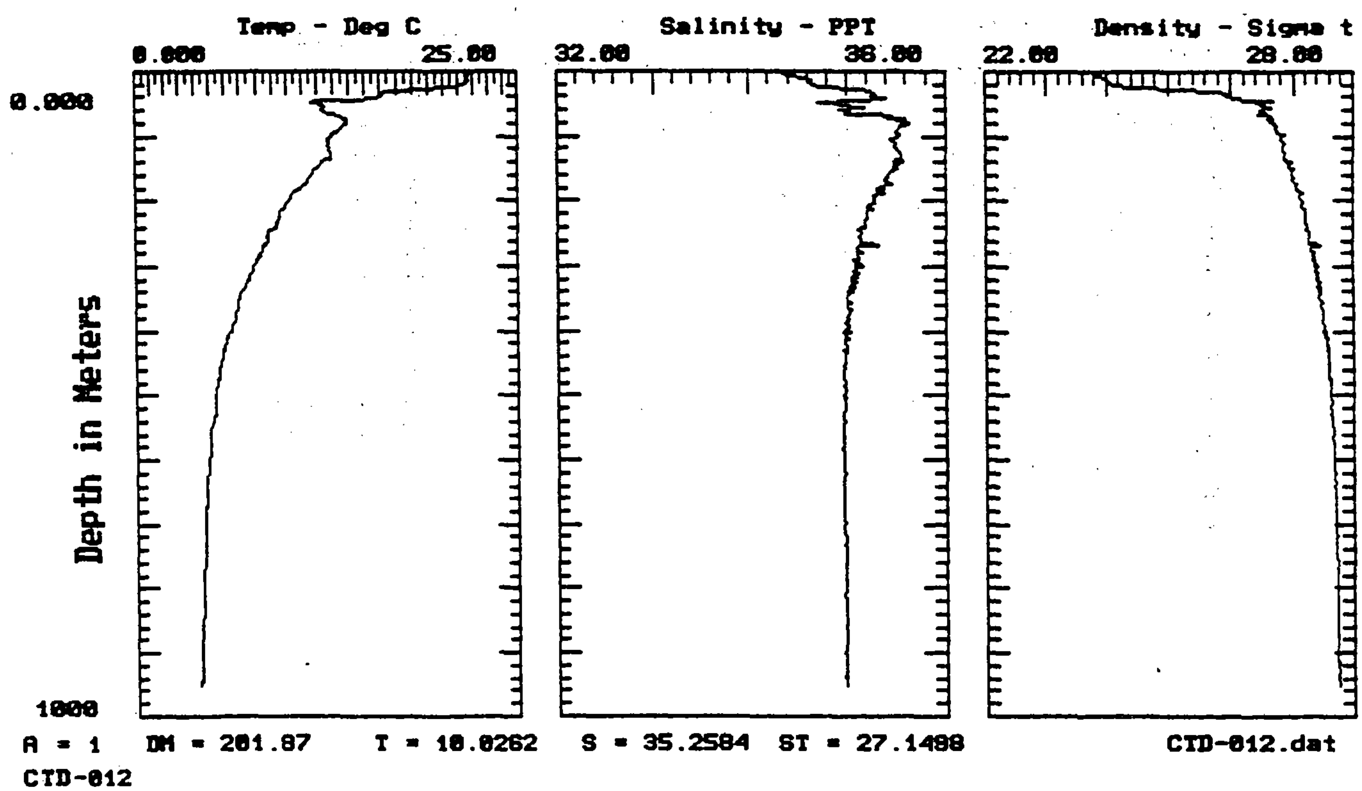
CTD-009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Density - Sigma t
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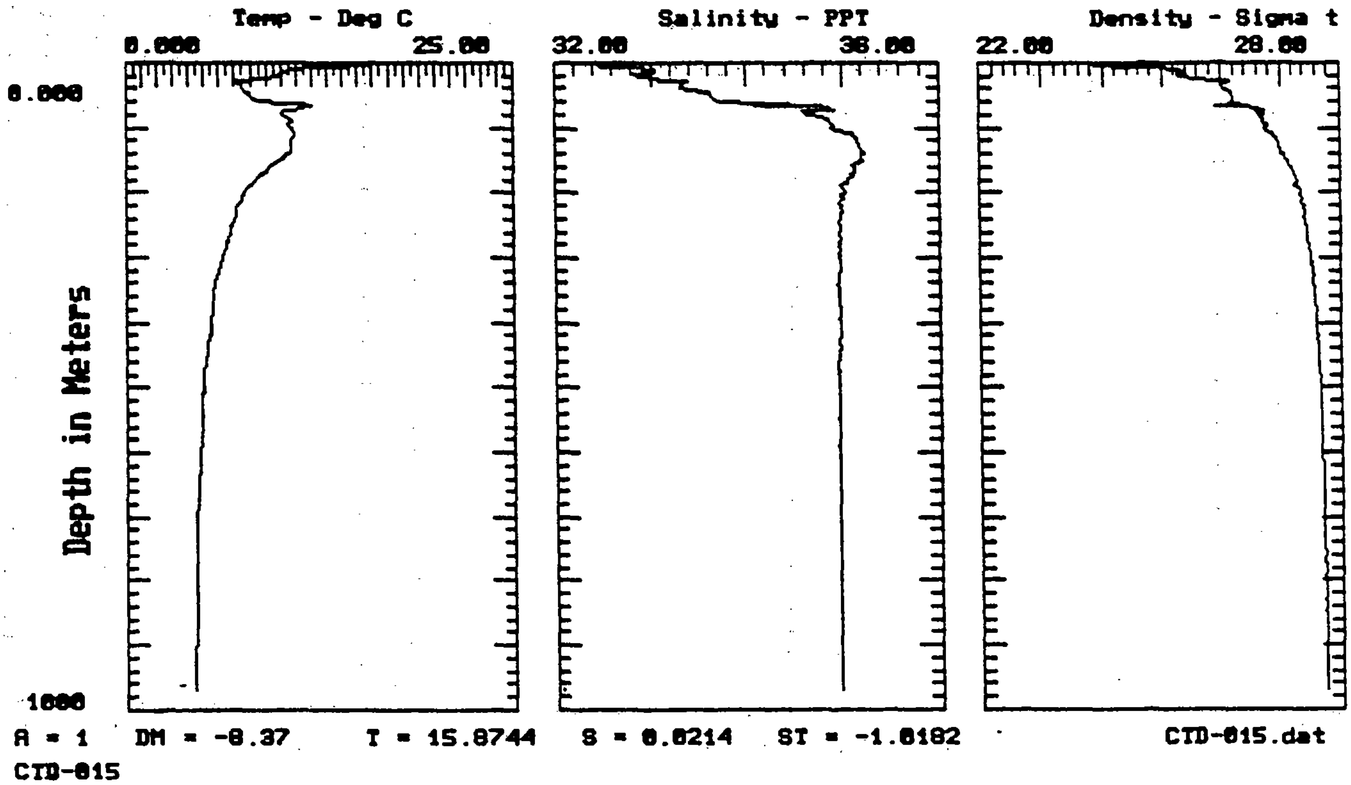
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Density - Sigma t
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28.00
0.000
Depth in Meters
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DM = -0.37
T = 15.0744
S = 0.0214
ST = -1.0182
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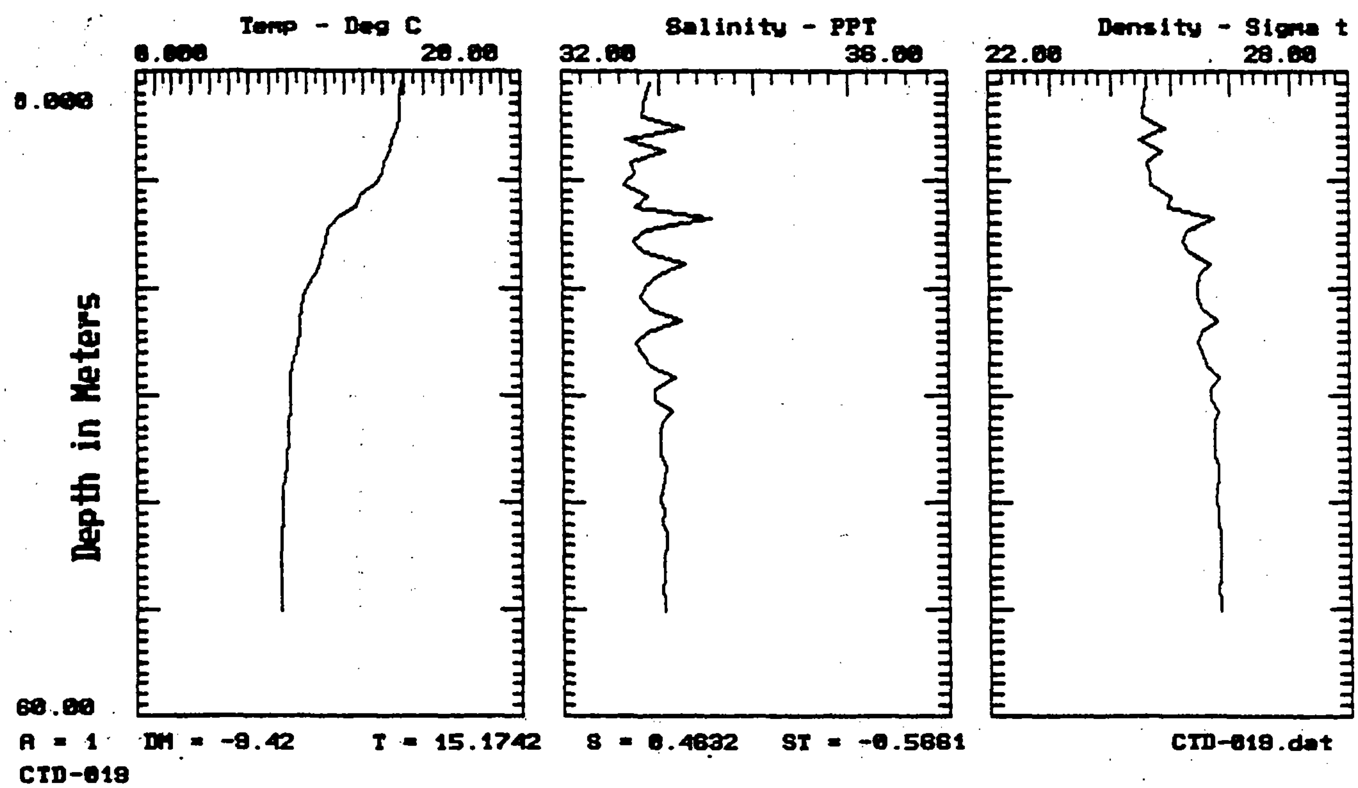
CTD-015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Salinity - PPT
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Density - Sigma t
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28.00
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DM = -0.42
T = 15.1742
S = 0.4632
ST = -0.5661
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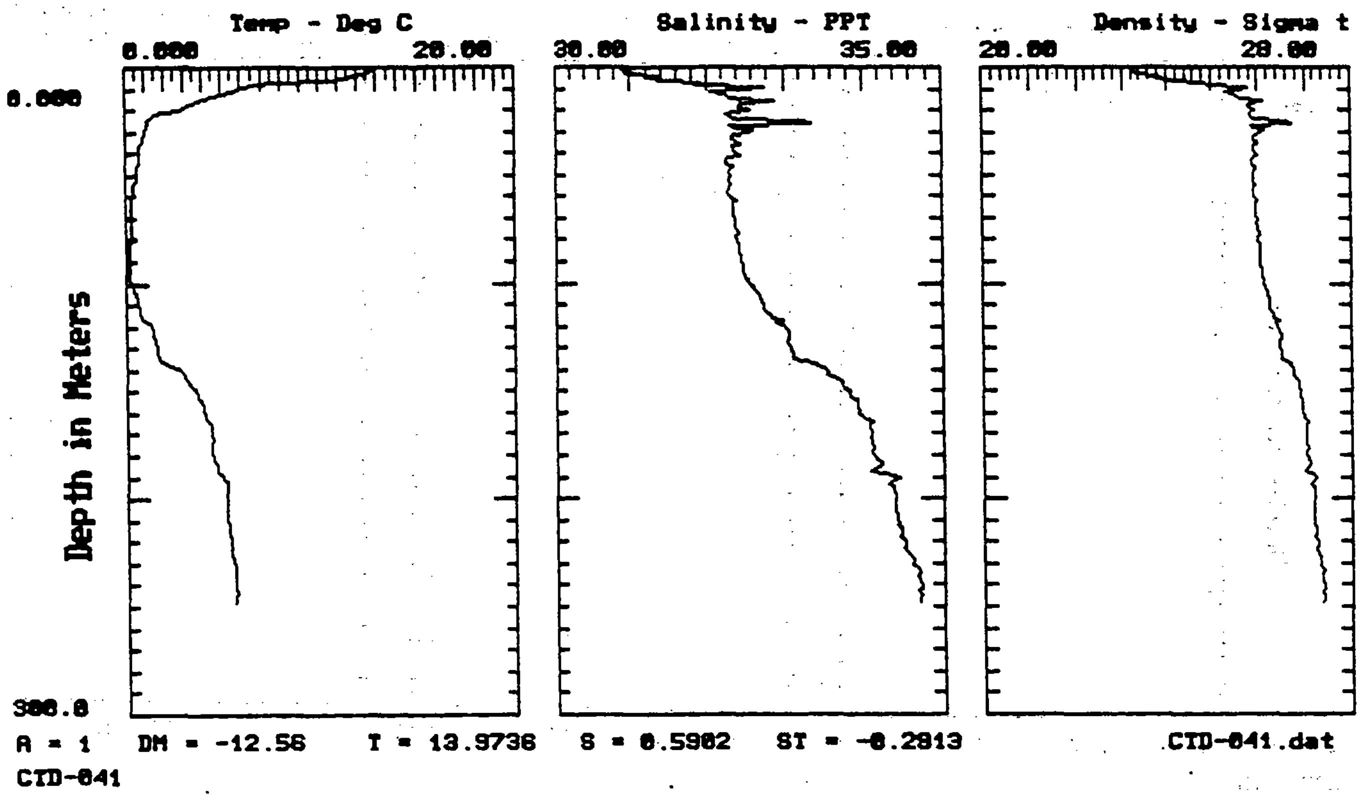
CTD-019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Salinity - PPT
30.00
35.00
Density - Sigma t
20.00
28.00
0.000
Depth in Meters
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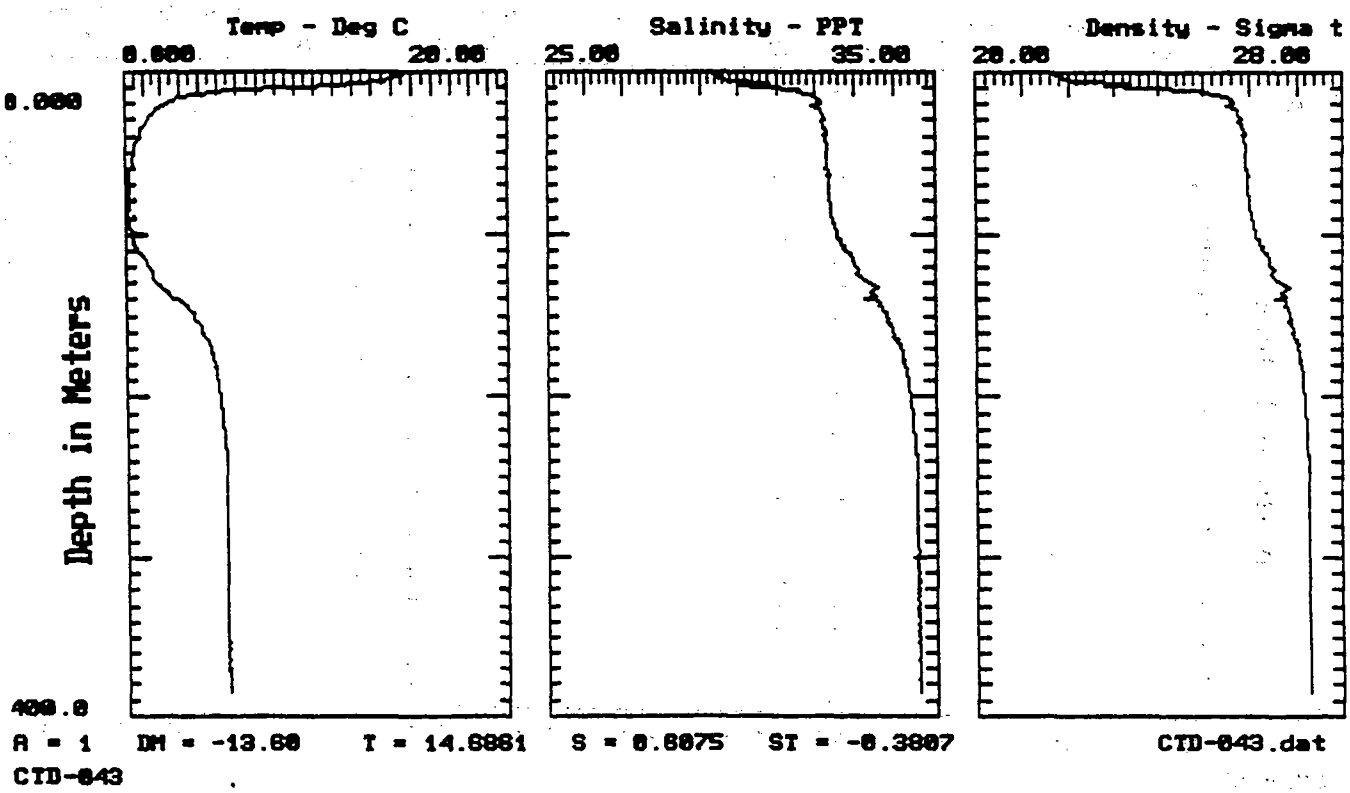
A = 1 DM = -12.56 T = 13.9736 S = 0.5902 ST = -0.2813
CTD-041.dat
CTD-041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Density - Sigma t
20.00
28.00
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A = 1 DM = -13.60 T = 14.0081 S = 0.0075 ST = -0.3807
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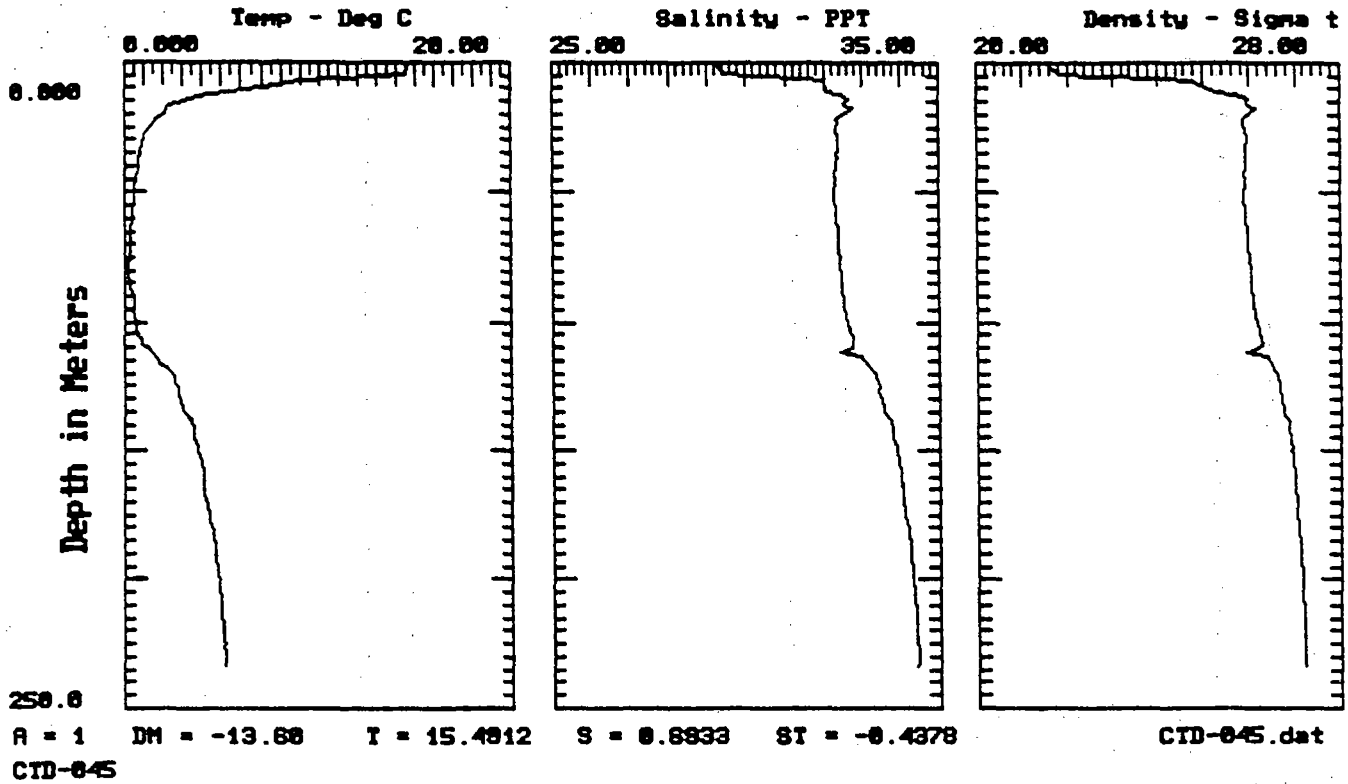
CTD-043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Density - Sigma t
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Depth in Meters
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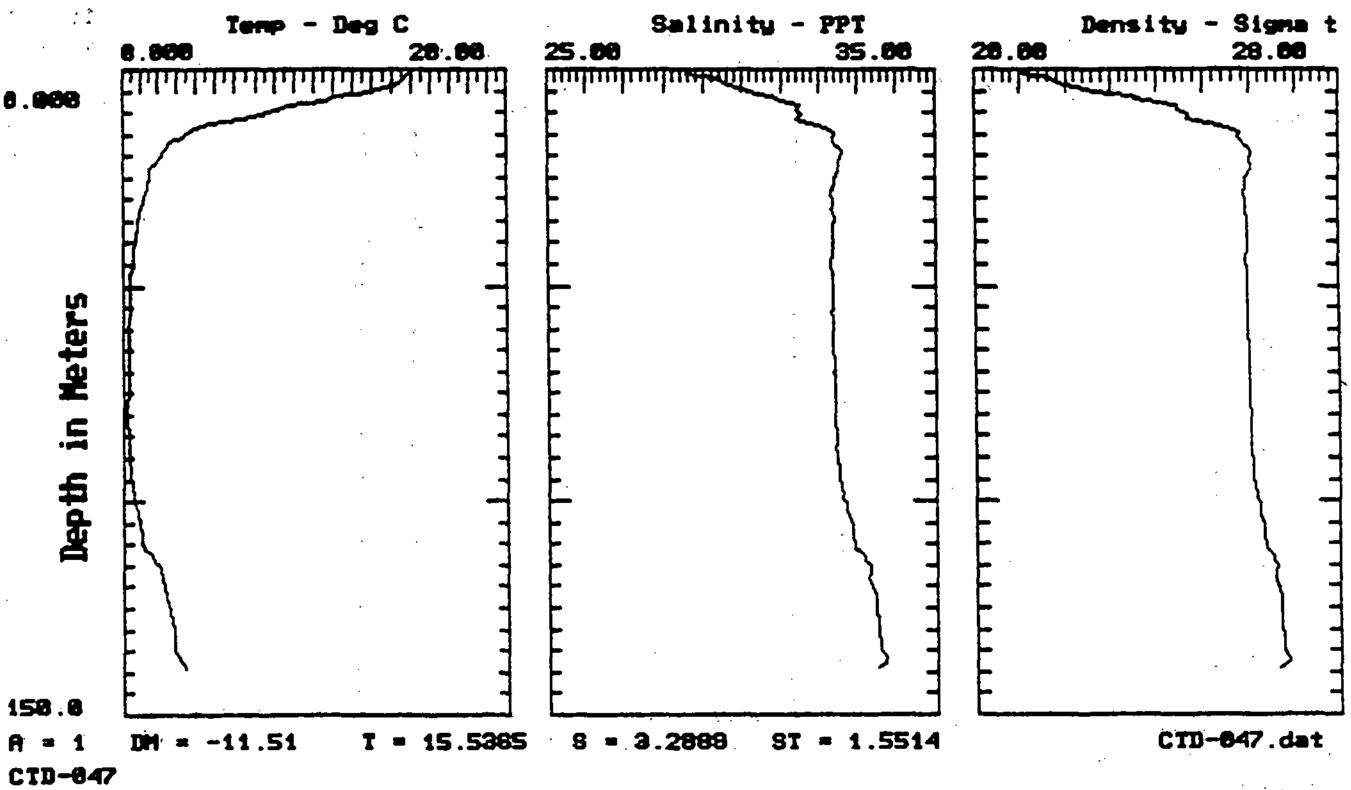
A = 1 DM = -13.60 T = 15.4812 S = 0.8833 ST = -0.4378 CTD-045.dat
CTD-045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Salinity - PPT
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Density - Sigma t
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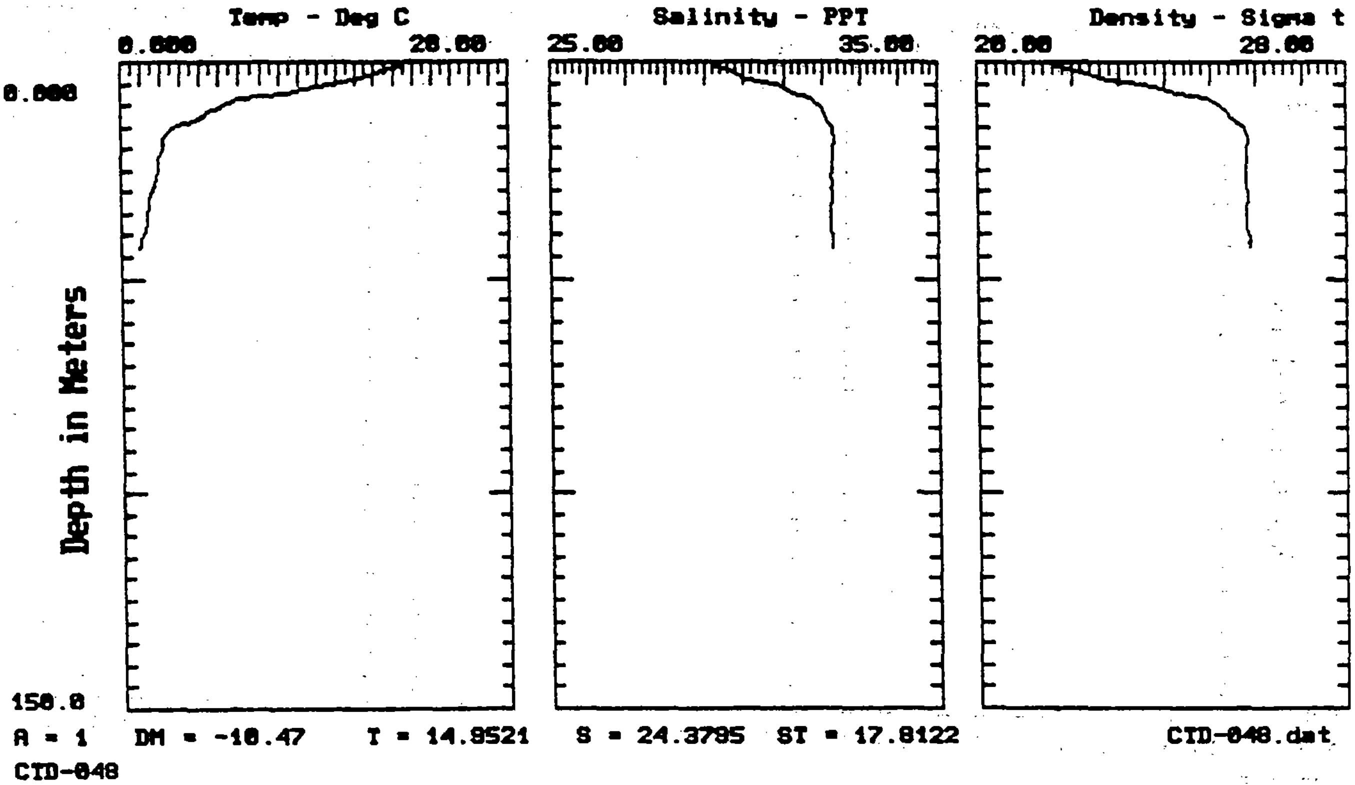
CTD-047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Salinity - PPT
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Density - Sigma t
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28.00
0.000
Depth in Meters
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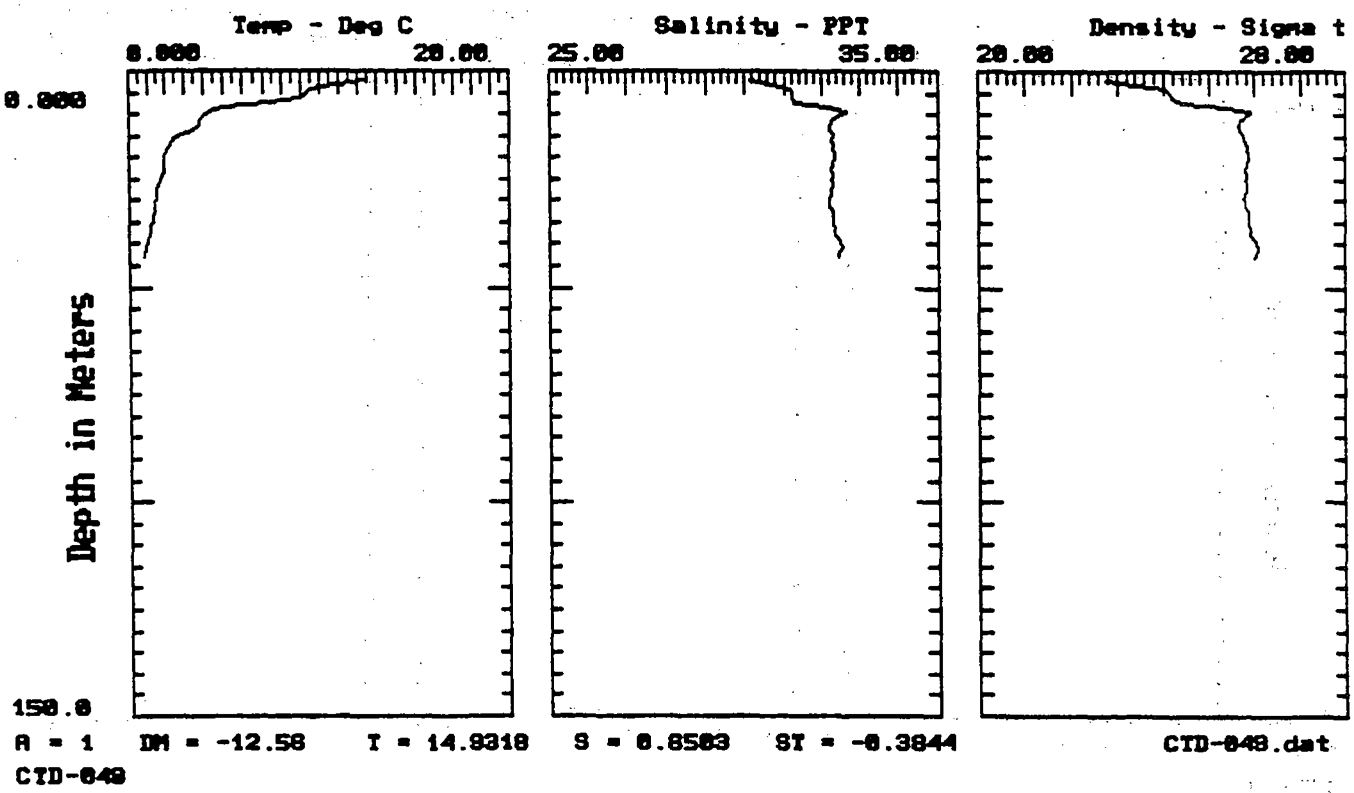
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Density - Sigma t
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0.000
Depth in Meters
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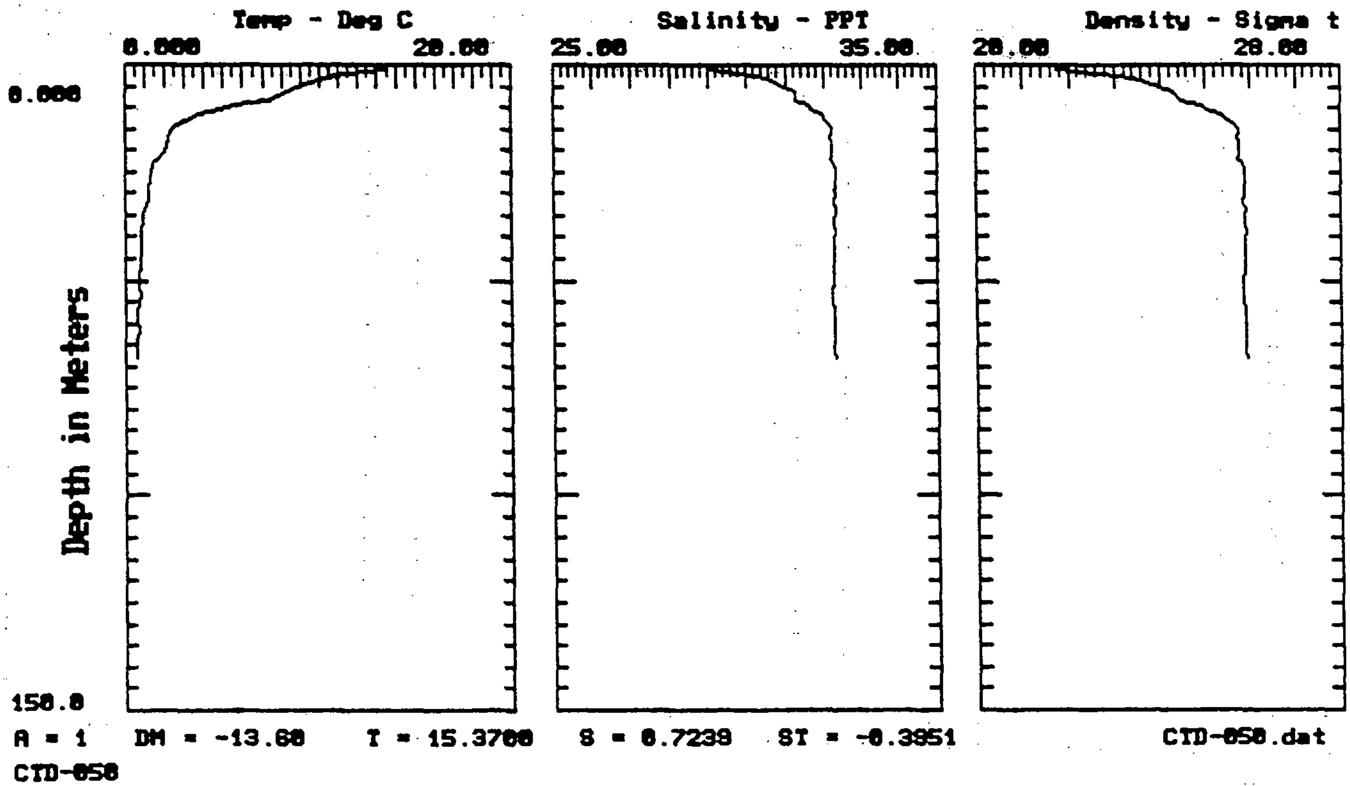
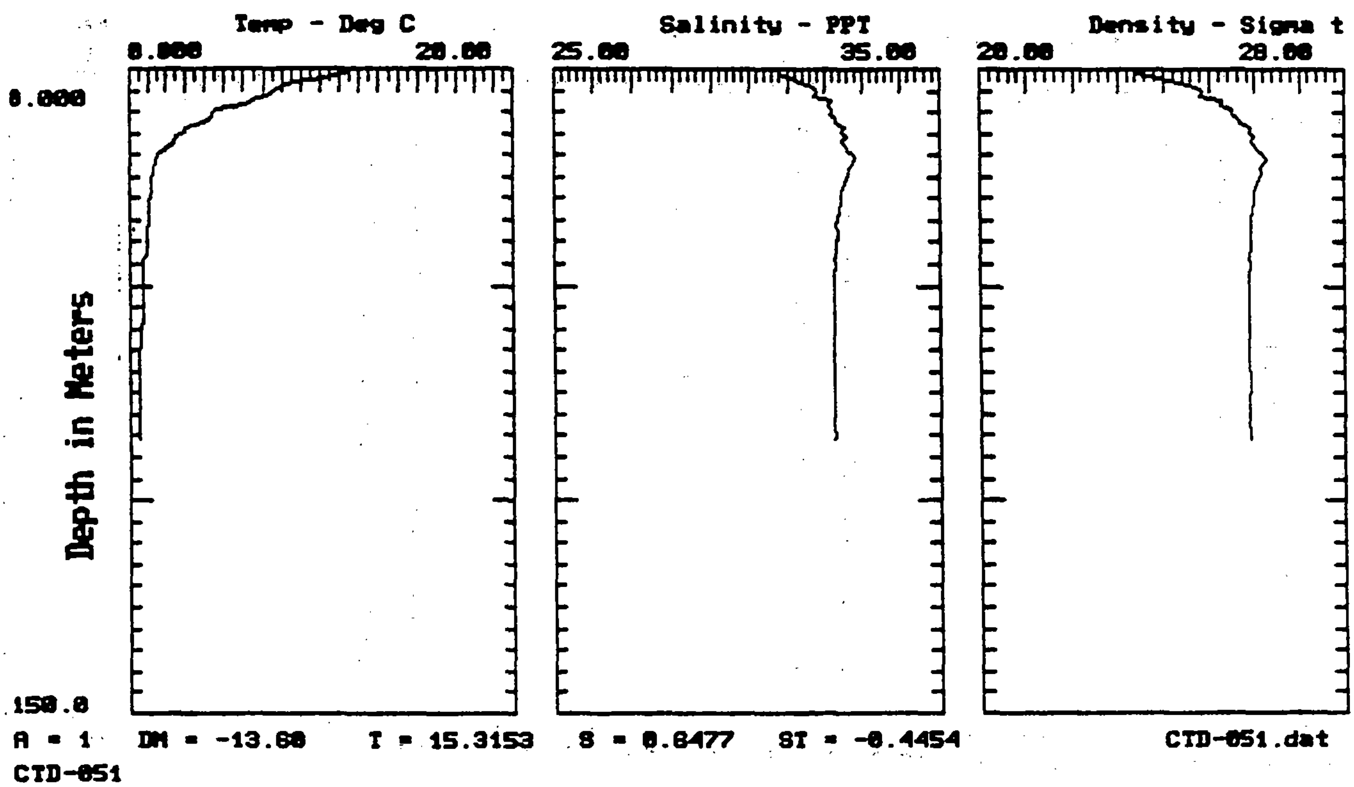
A = 1 DM = -12.58 T = 14.8318 S = 0.8583 ST = -0.3844 CTD-049.dat
CTD-049


Temp - Deg C
0.000
20.00
Salinity - PPT
25.00
35.00
Density - Sigma t
20.00
28.00
0.000
Depth in Meters
150.0
A = 1
DM = -13.00
T = 15.3700
S = 0.7239
ST = -0.3951
CTD-050.dat
CTD-050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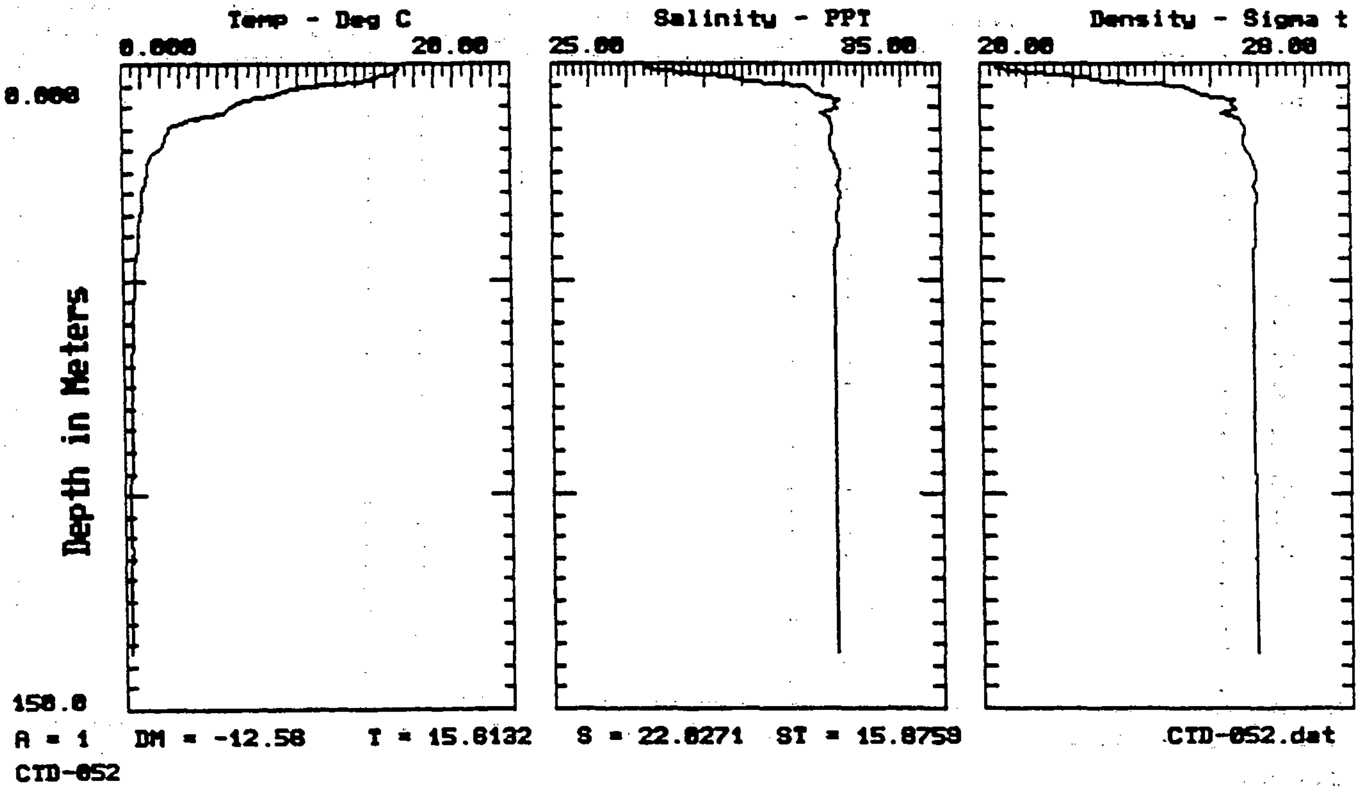
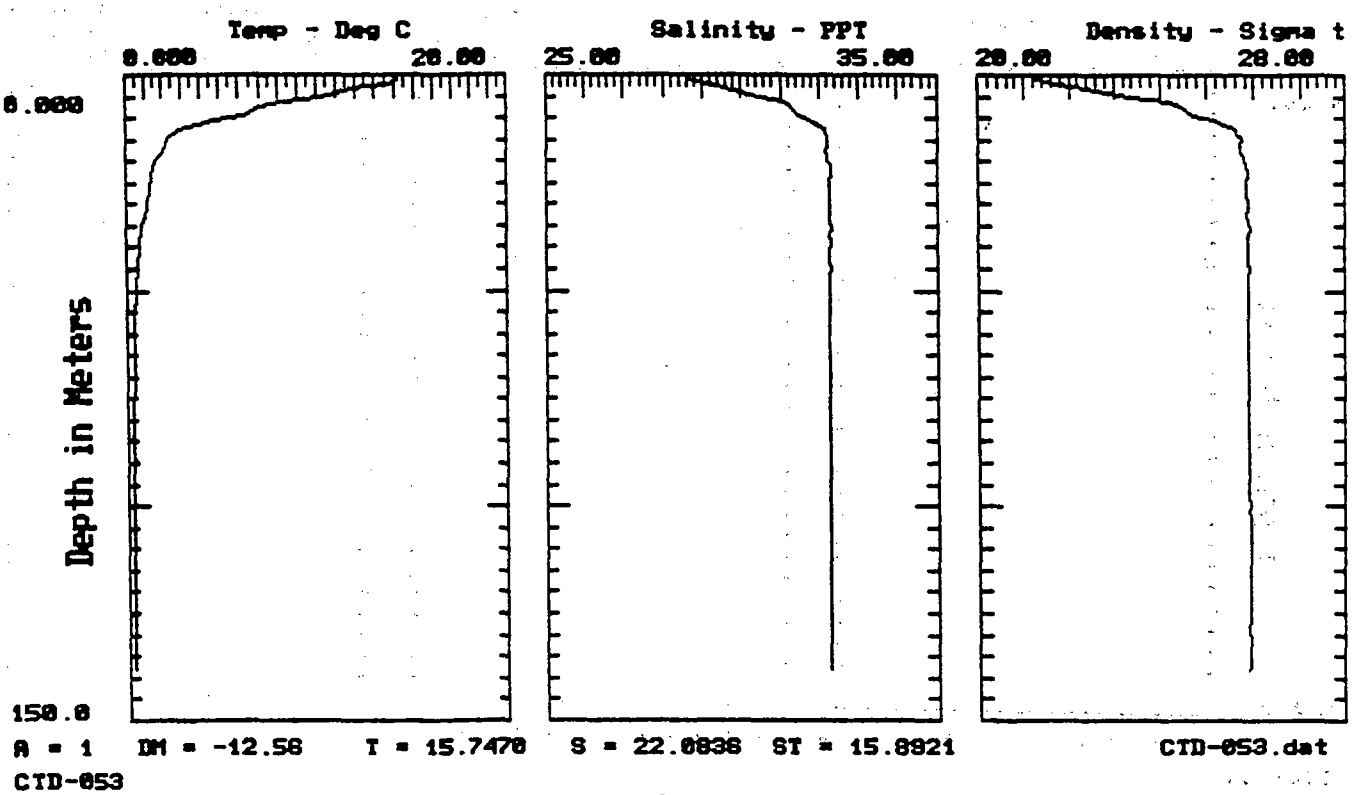
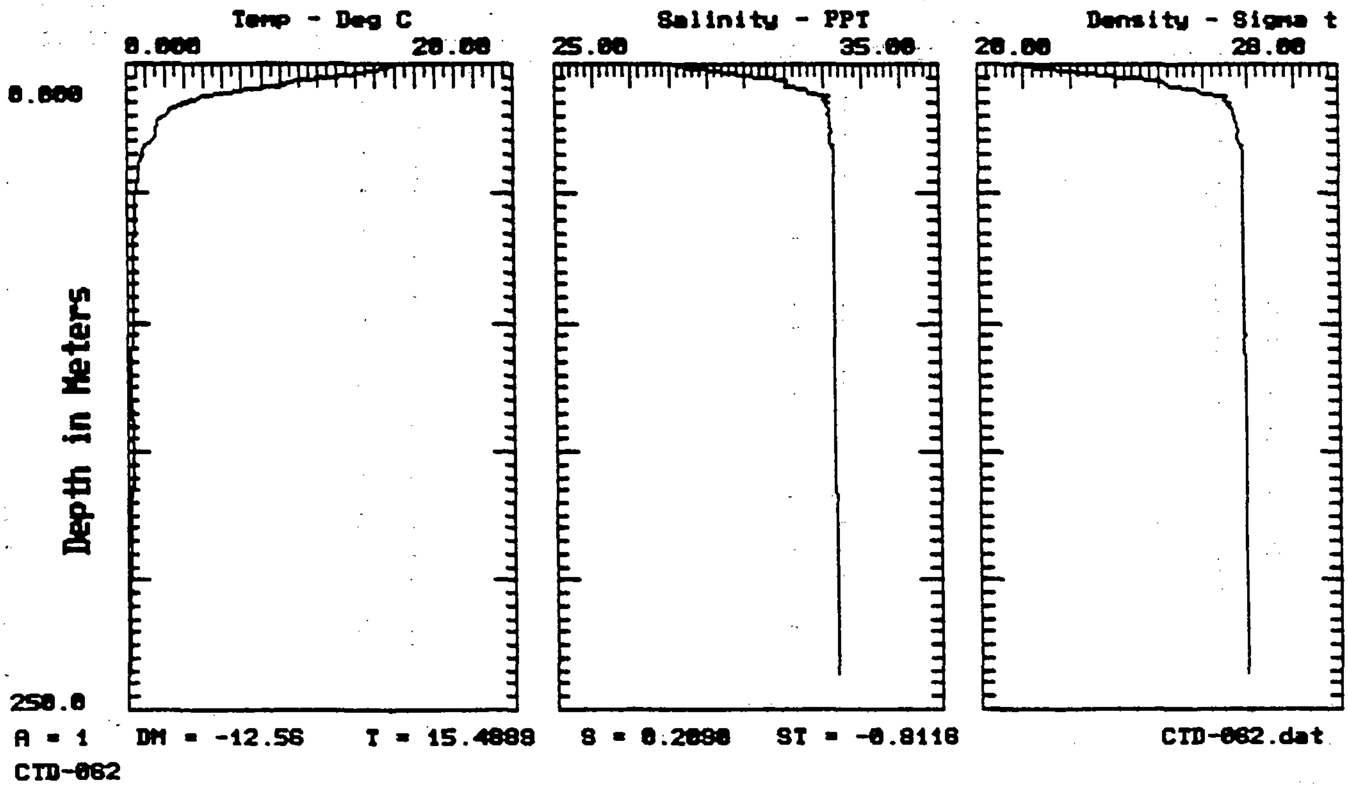
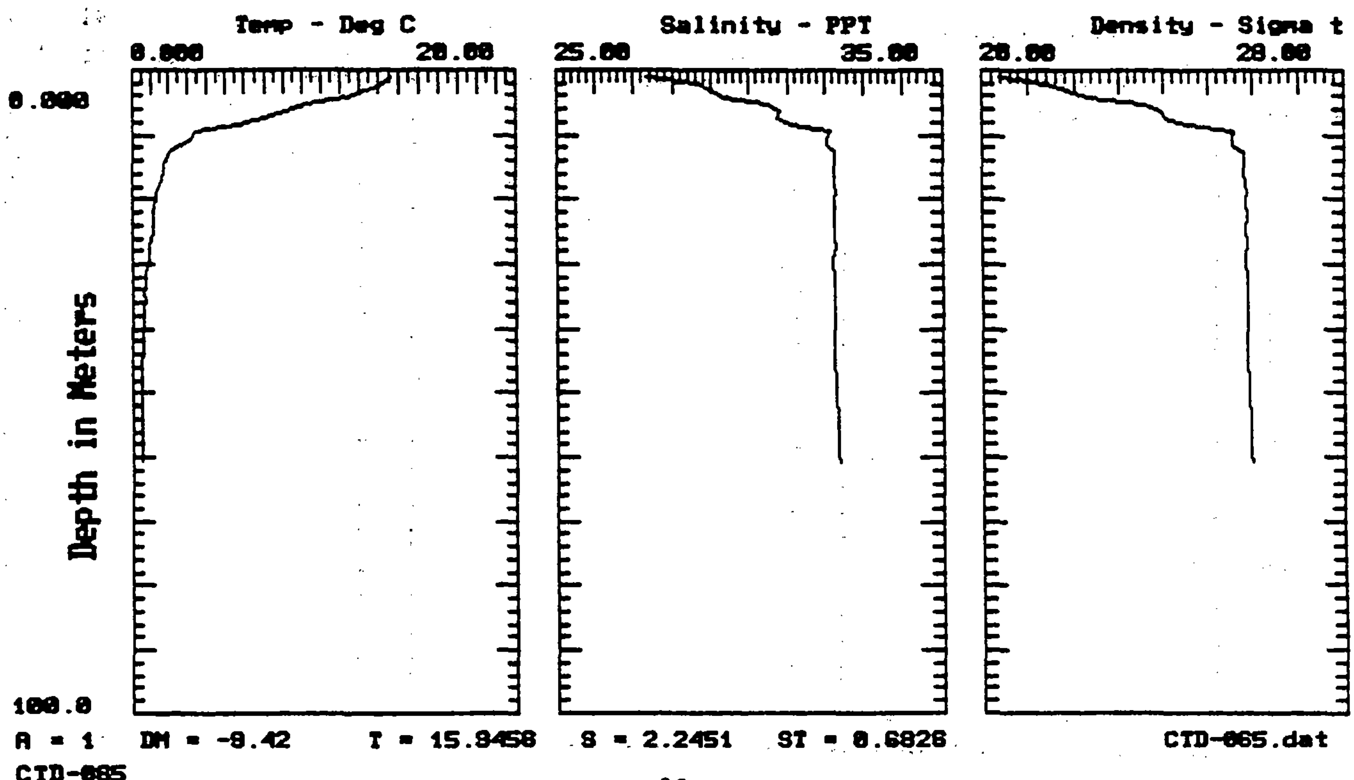
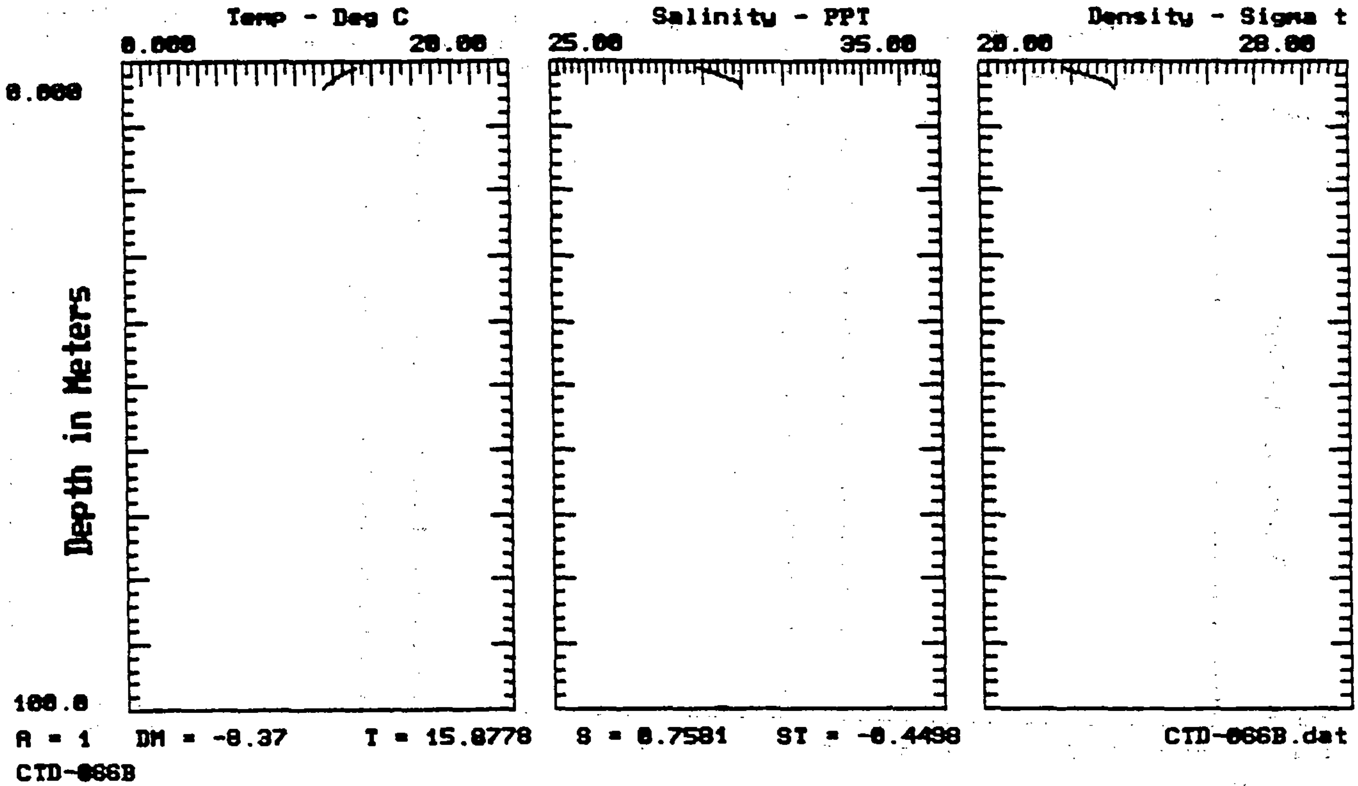
20.00
Salinity - PPT
25.00
35.00
Density - Sigma t
20.00
28.00
0.000
Depth in Meters
150.0
A = 1
DM = -13.00
T = 15.3153
S = 0.6477
ST = -0.4454
CTD-051.dat
CTD-051

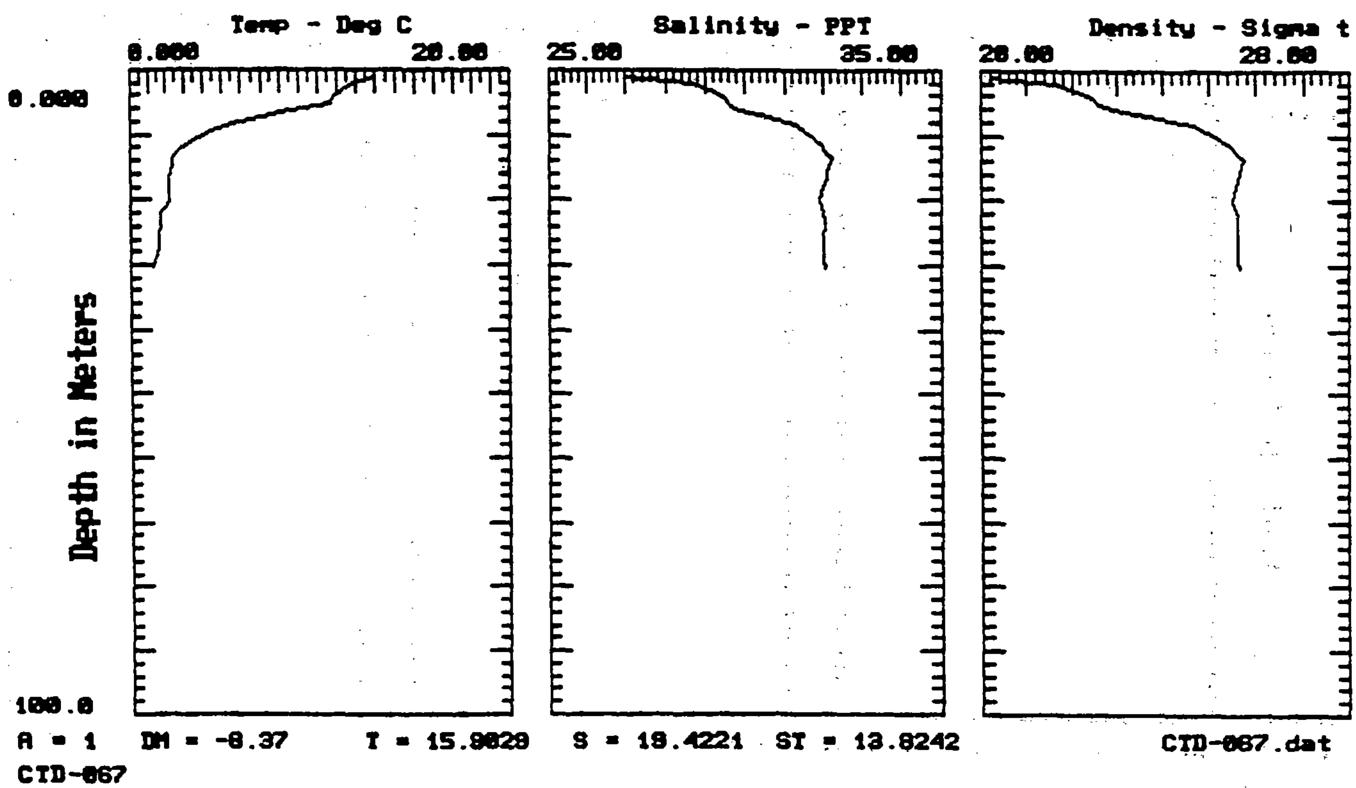

Temp - Deg C
0.000
20.00
Salinity - PPT
25.00
35.00
Density - Sigma t
20.00
28.00
0.000
Depth in Meters
150.0
A = 1
DM = -12.58
T = 15.6132
S = 22.0271
ST = 15.0759
CTD-052.dat
CTD-052

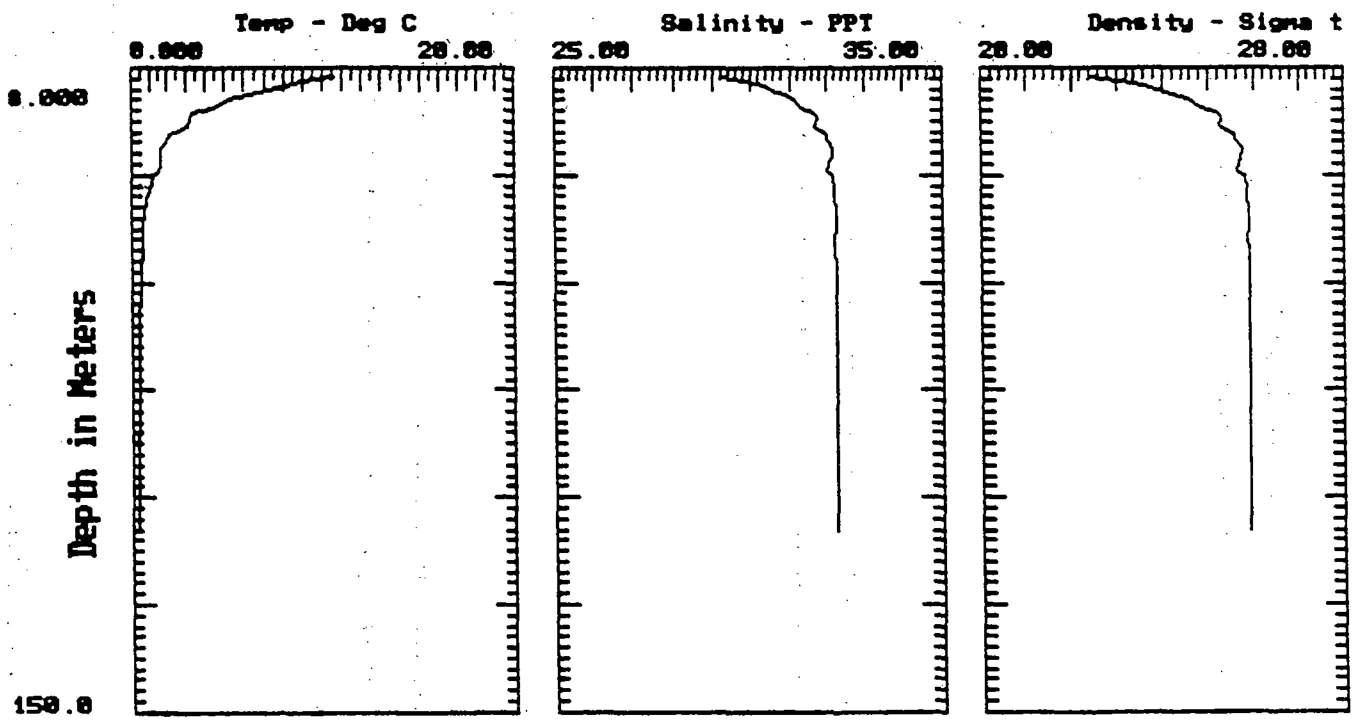

Temp - Deg C
0.000
20.00
Salinity - PPT
25.00
35.00
Density - Sigma t
20.00
28.00
0.000
Depth in Meters
150.0
A = 1
DM = -12.58
T = 15.7470
S = 22.0836
ST = 15.8921
CTD-053.dat
CTD-053


Temp - Deg C
0.000
20.00
Salinity - PPT
25.00
35.00
Density - Sigma t
20.00
28.00
0.000
250.0
Depth in Meters
A = 1
DM = -12.56
T = 15.4000
S = 0.2090
ST = -0.8116
CTD-062.dat
CTD-062

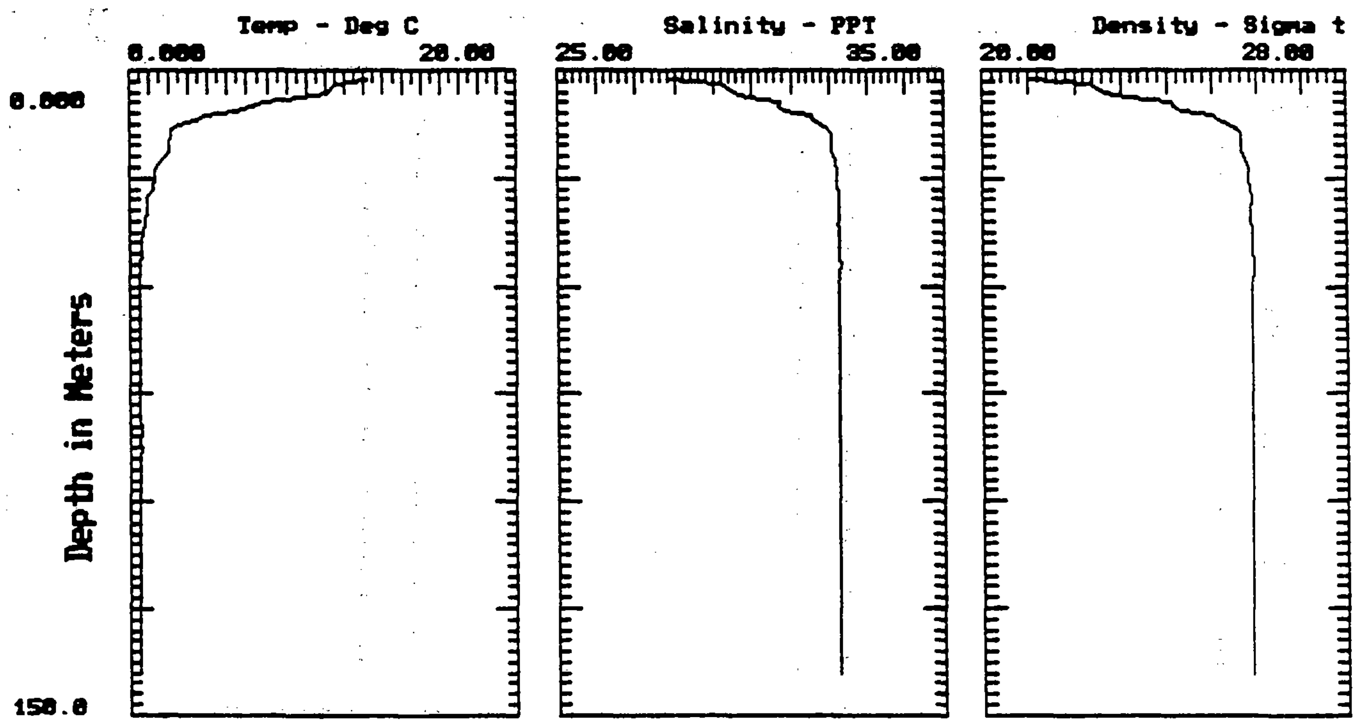

Temp - Deg C
0.000
20.00
Salinity - PPT
25.00
35.00
Density - Sigma t
20.00
28.00
0.000
100.0
Depth in Meters
A = 1
DM = -8.42
T = 15.8458
S = 2.2451
ST = 0.6826
CTD-065.dat
CTD-065


Temp - Deg C
0.000
20.00
Salinity - PPT
25.00
35.00
Density - Sigma t
20.00
28.00
0.000
Depth in Meters
100.0
A = 1 DM = -8.37 T = 15.8778 S = 8.7581 ST = -8.4498
CTD-066B.dat
CTD-066B

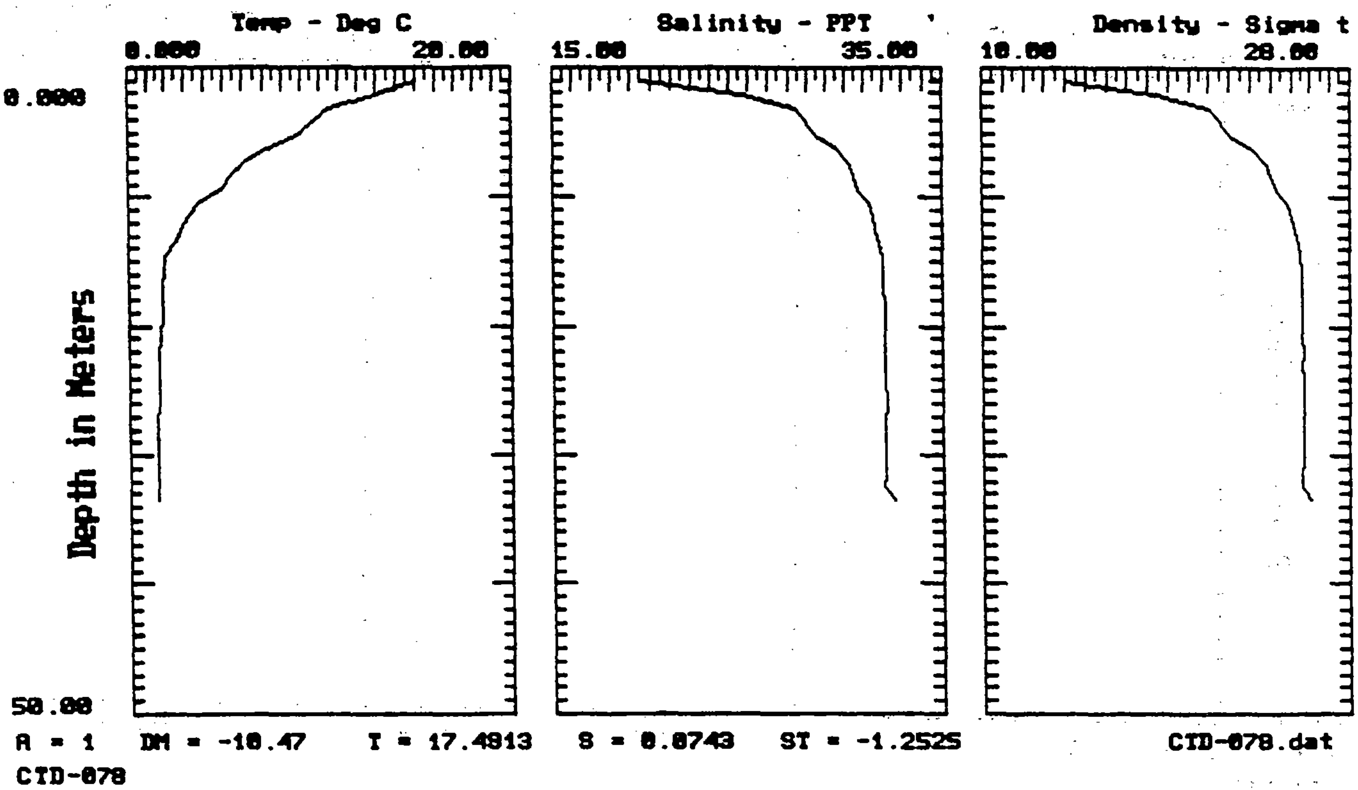

Temp - Deg C
0.000
20.00
Salinity - PPT
25.00
35.00
Density - Sigma t
20.00
28.00
0.000
Depth in Meters
100.0
A = 1 DM = -8.37 T = 15.9828 S = 18.4221 ST = 13.8242
CTD-067.dat
CTD-067

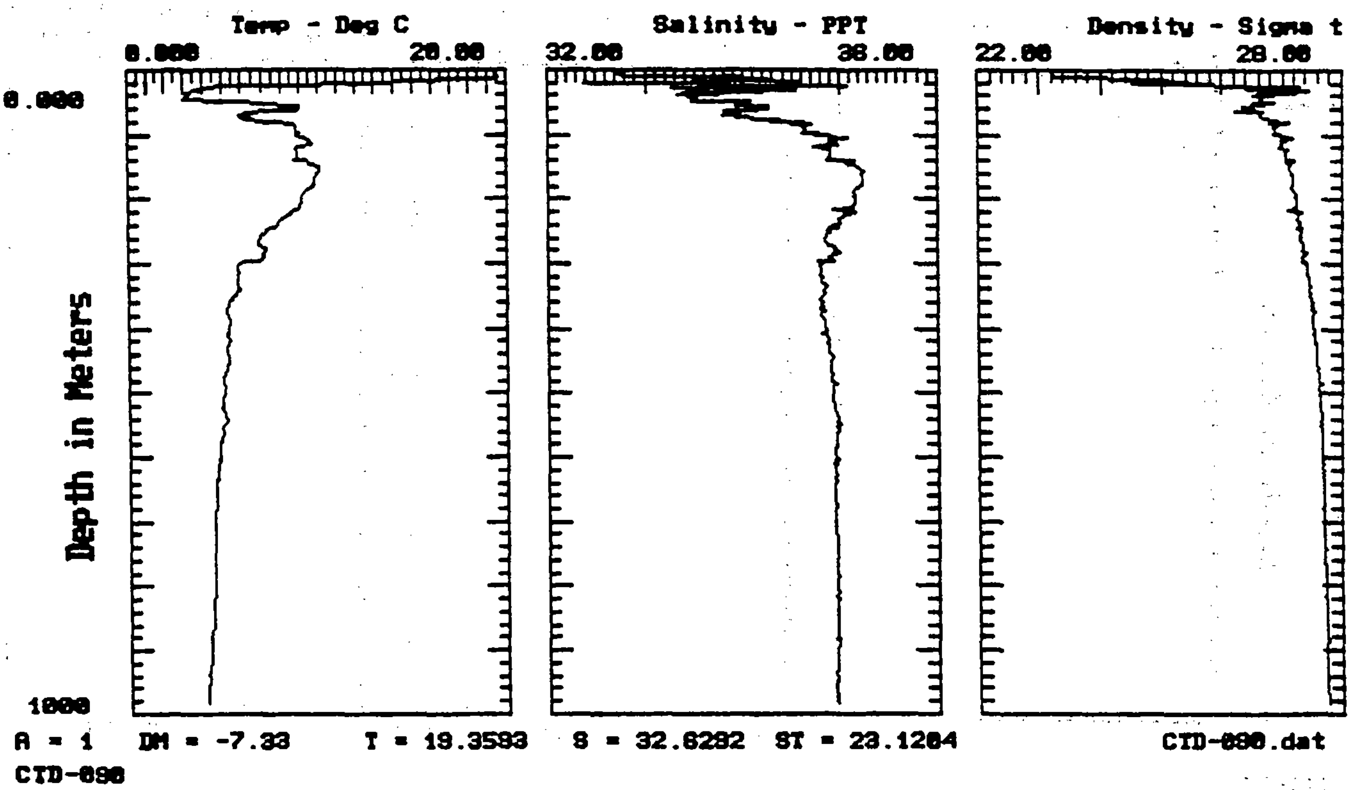


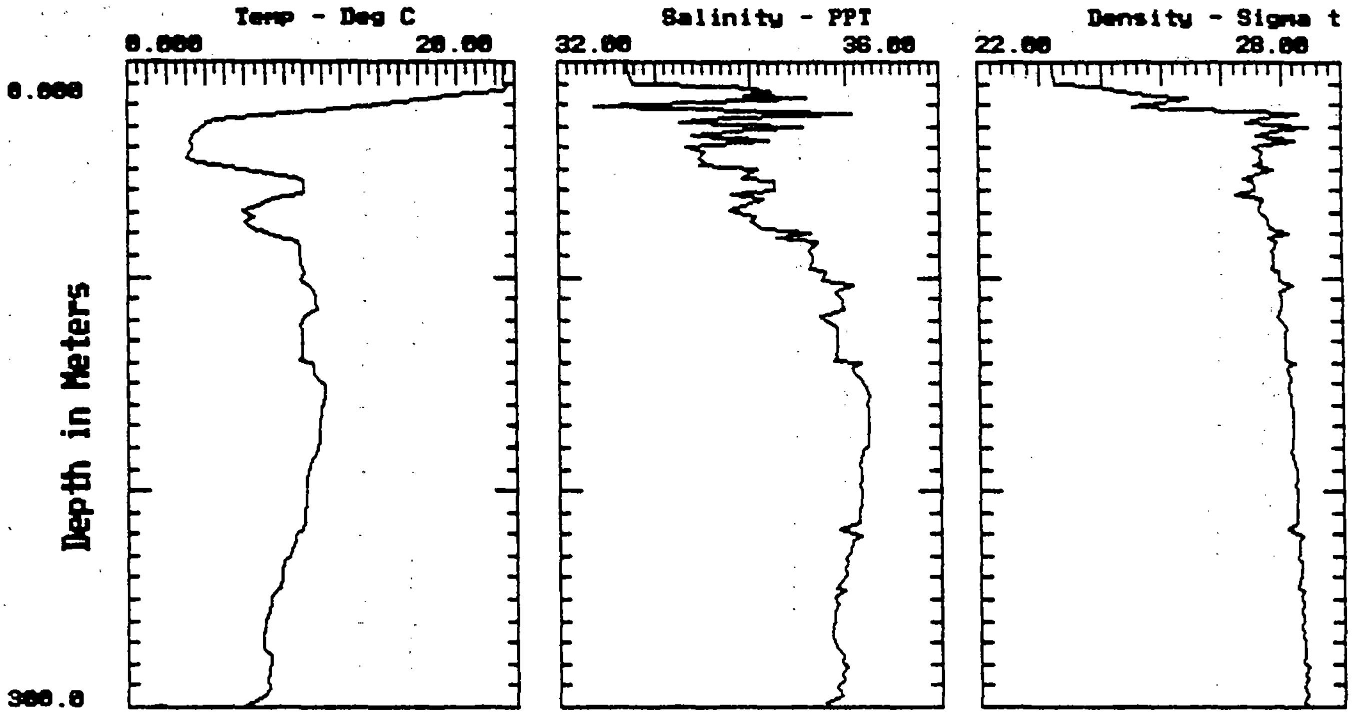
A = 1 DM = -11.51 T = 15.8440 S = 0.1316 ST = -0.9440 CTD-068.dat
CTD-068



A = 1 DM = -12.50 T = 16.8364 S = 0.1164 ST = -1.1280 CTD-070.dat
CTD-070

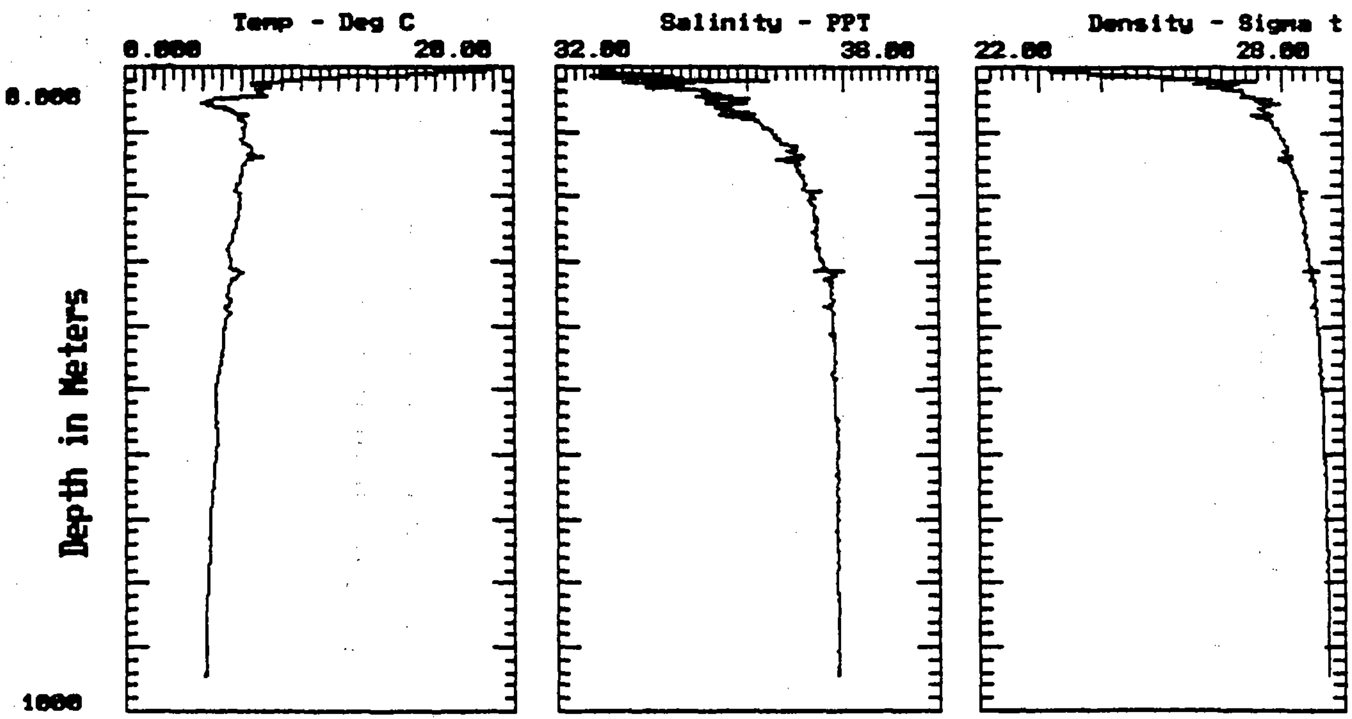

Temp - Deg C
0.000
20.00
Salinity - PPT
15.00
35.00
Density - Sigma t
10.00
28.00
0.000
50.00
Depth in Meters
A = 1
DM = -10.47
T = 17.4813
S = 0.0743
ST = -1.2525
CTD-070.dat
CTD-070


Temp - Deg C
0.000
20.00
Salinity - PPT
32.00
38.00
Density - Sigma t
22.00
28.00
0.000
1000
Depth in Meters
A = 1
DM = -7.33
T = 19.3583
S = 32.6282
ST = 23.1204
CTD-090.dat
CTD-090



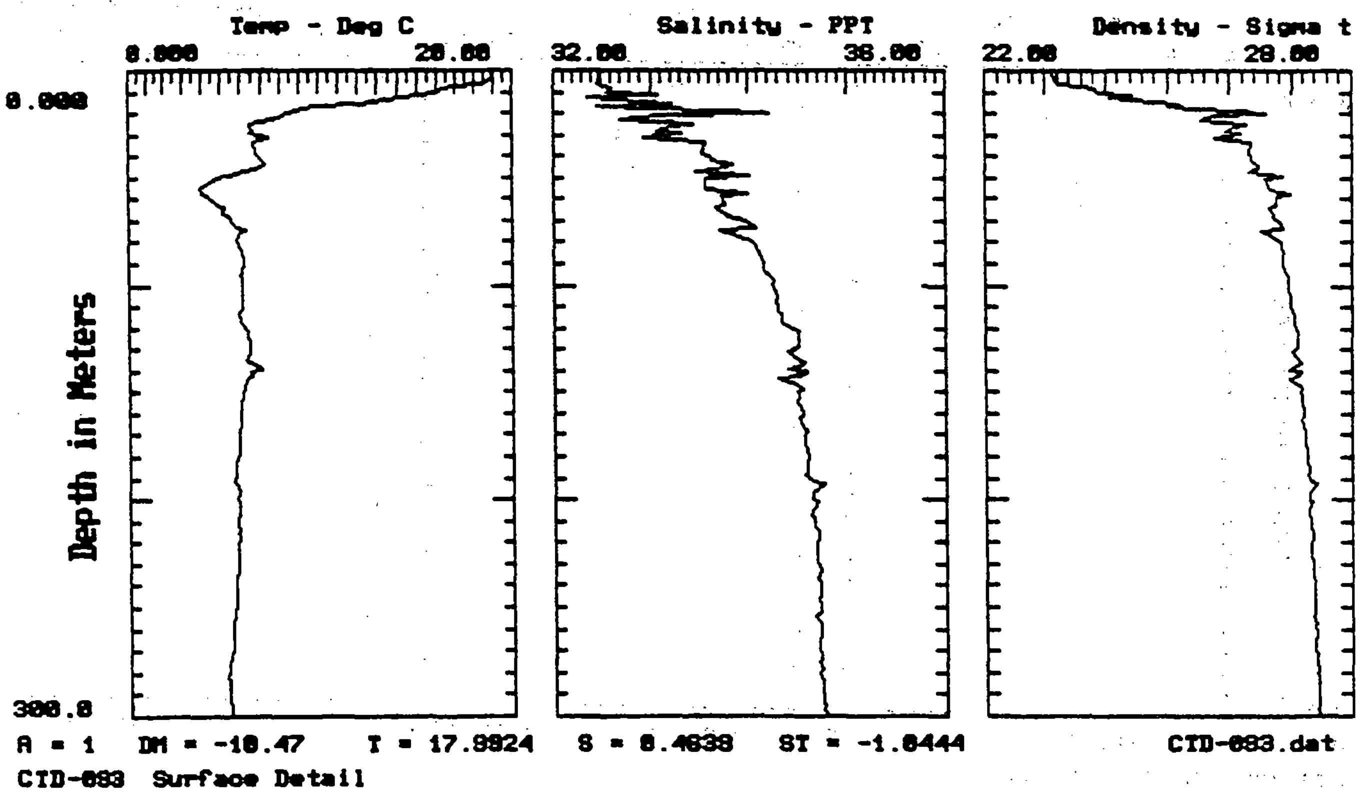
A = 1 DM = -7.33 T = 10.3593 S = 32.8282 ST = 23.1204 CTD-690.dat

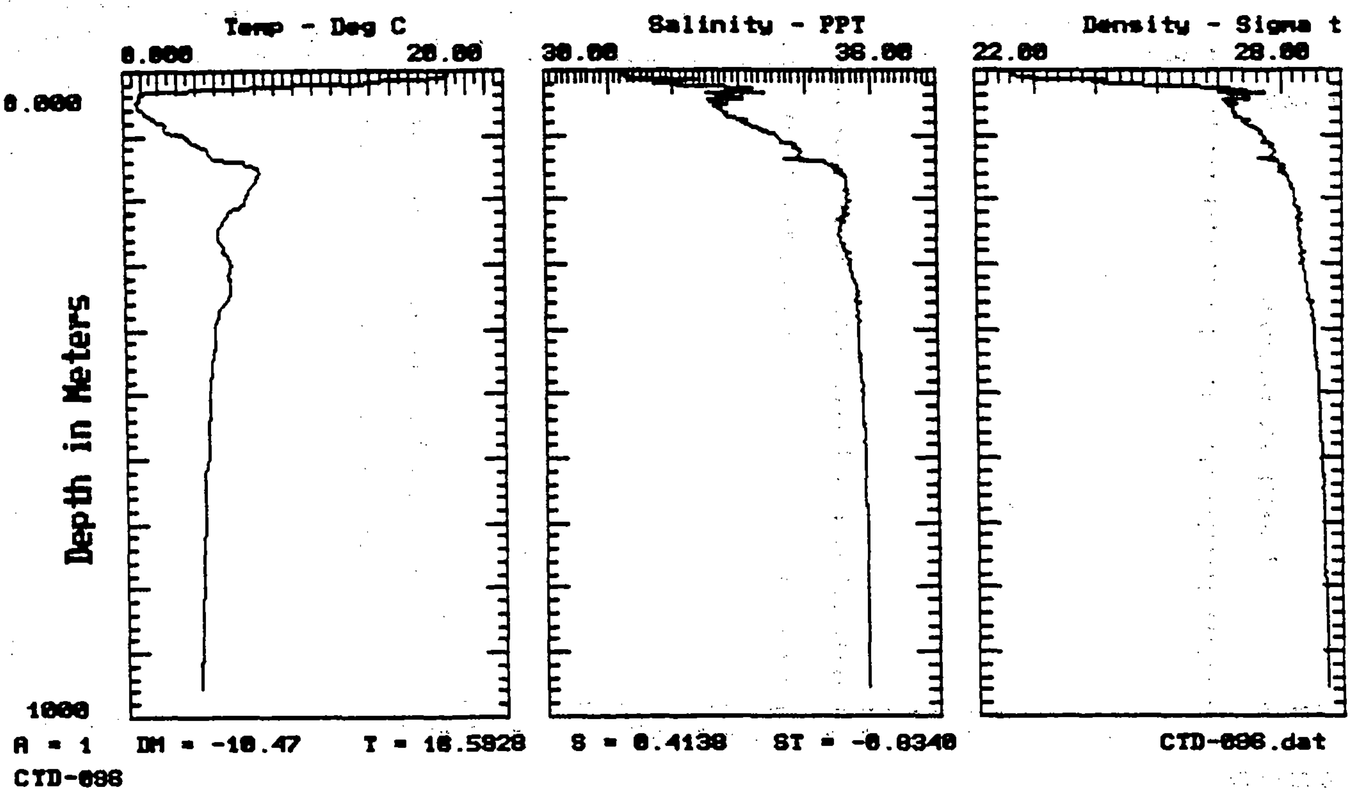
CTD-690 Surface Detail

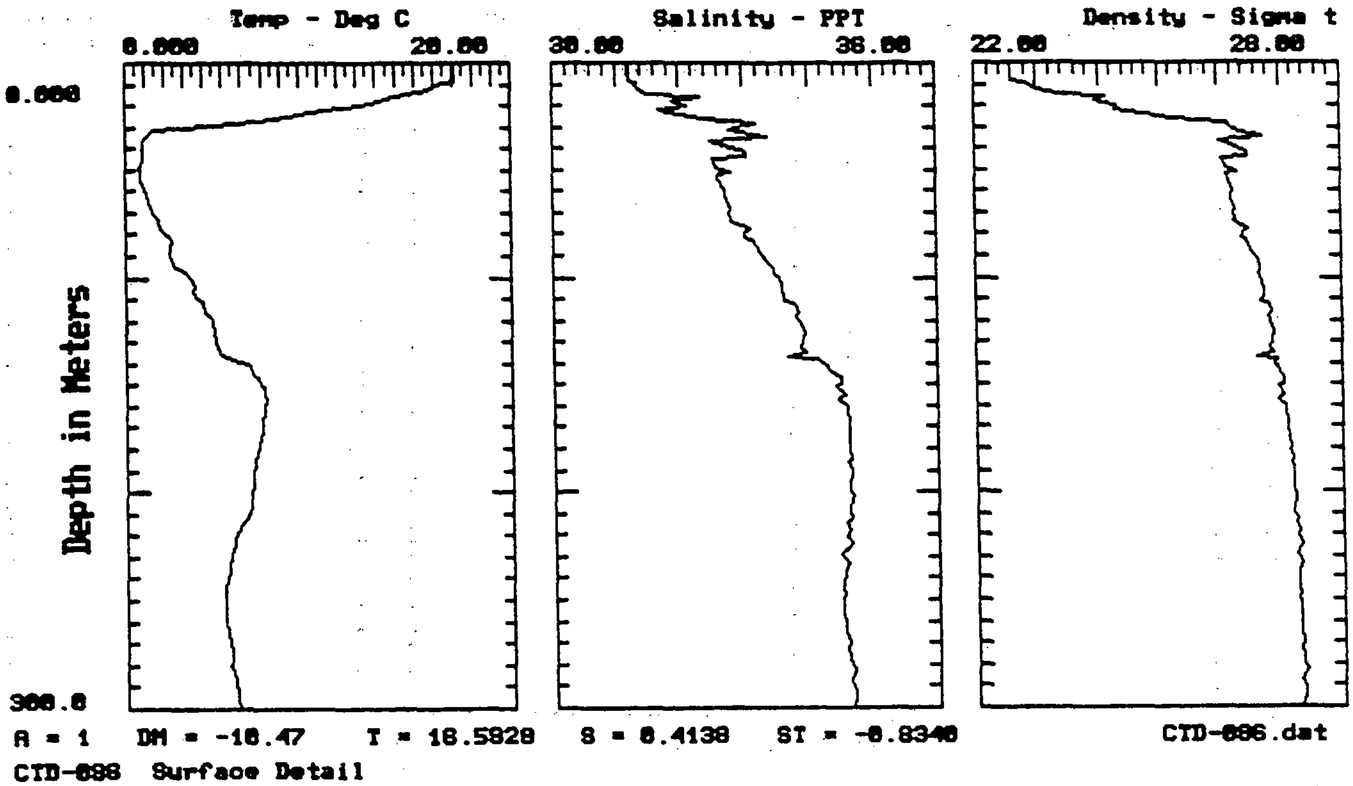


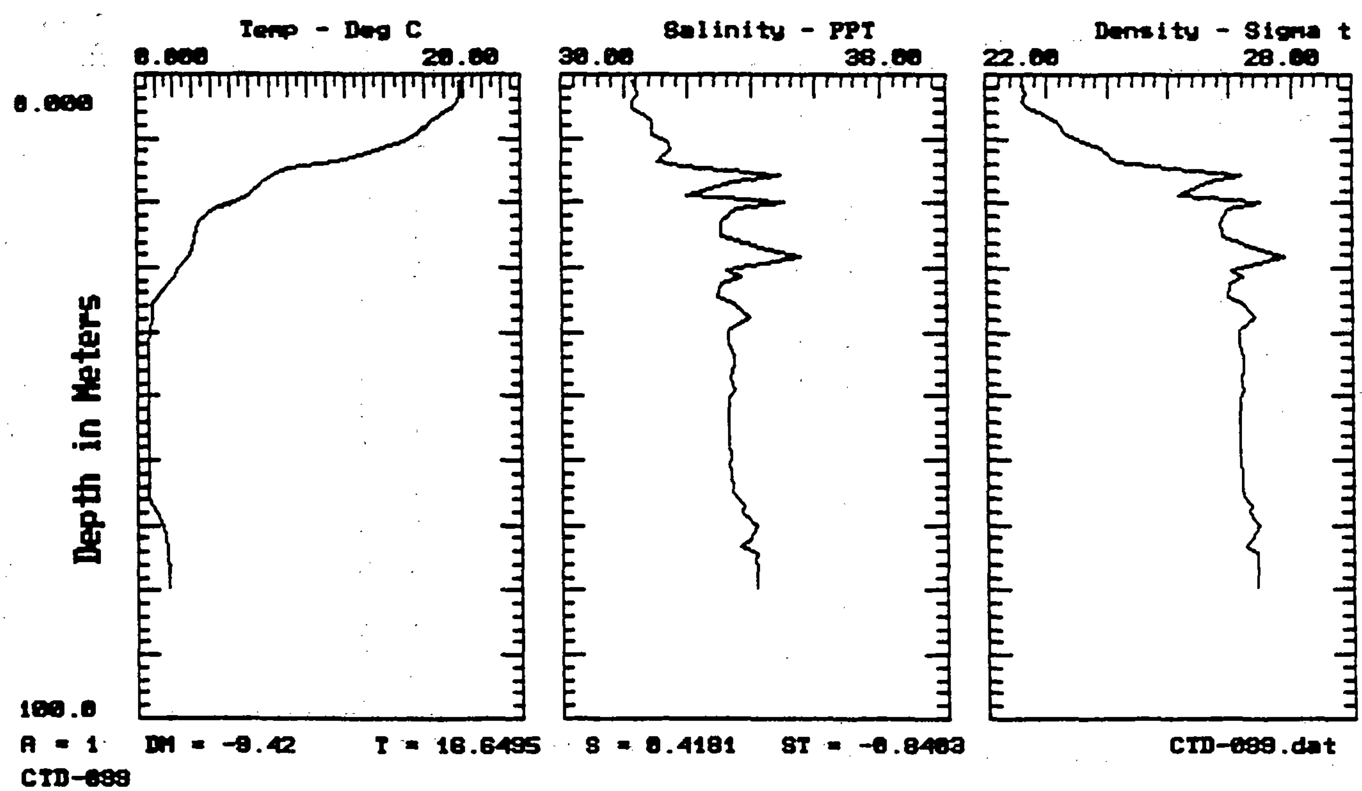
A = 1 DM = -10.47 T = 17.9924 S = 0.4038 ST = -1.0444 CTD-693.dat

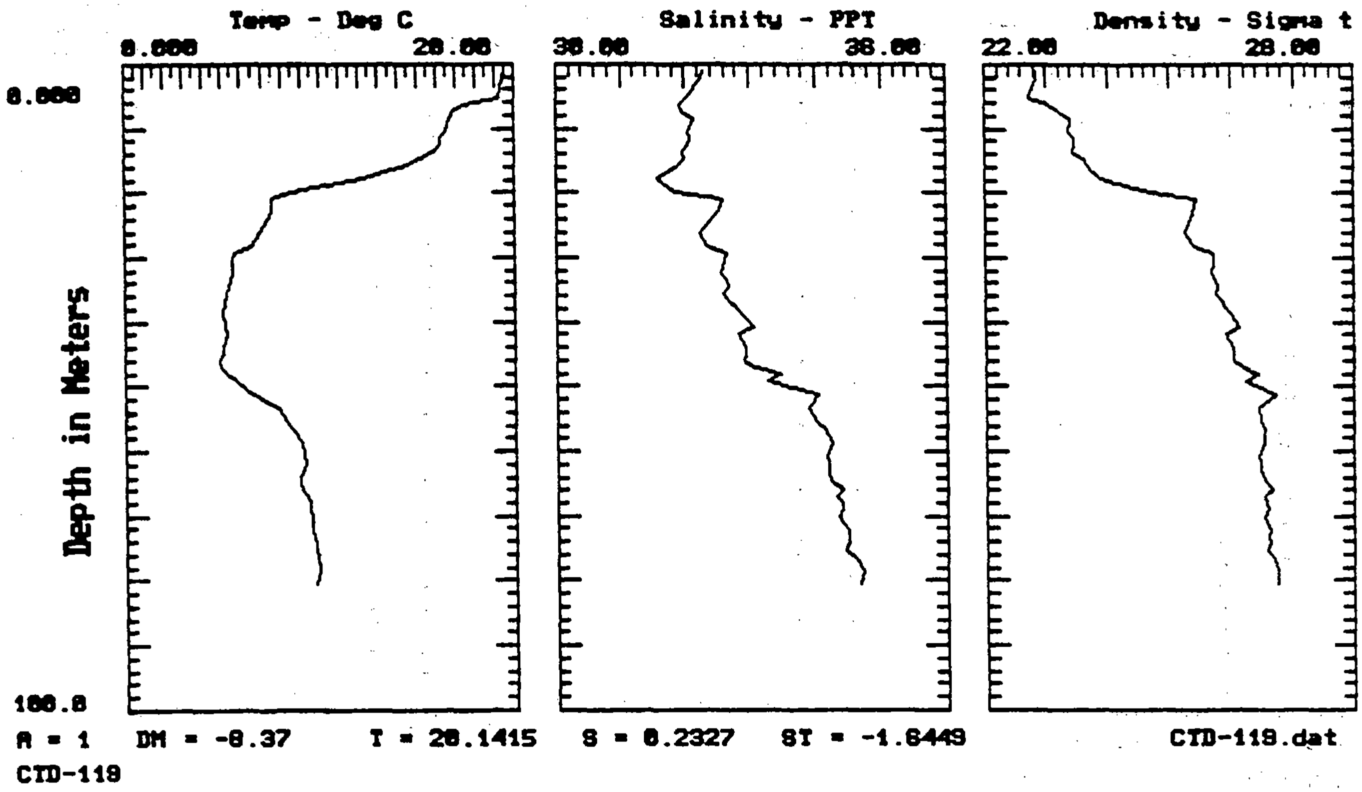
CTD-693

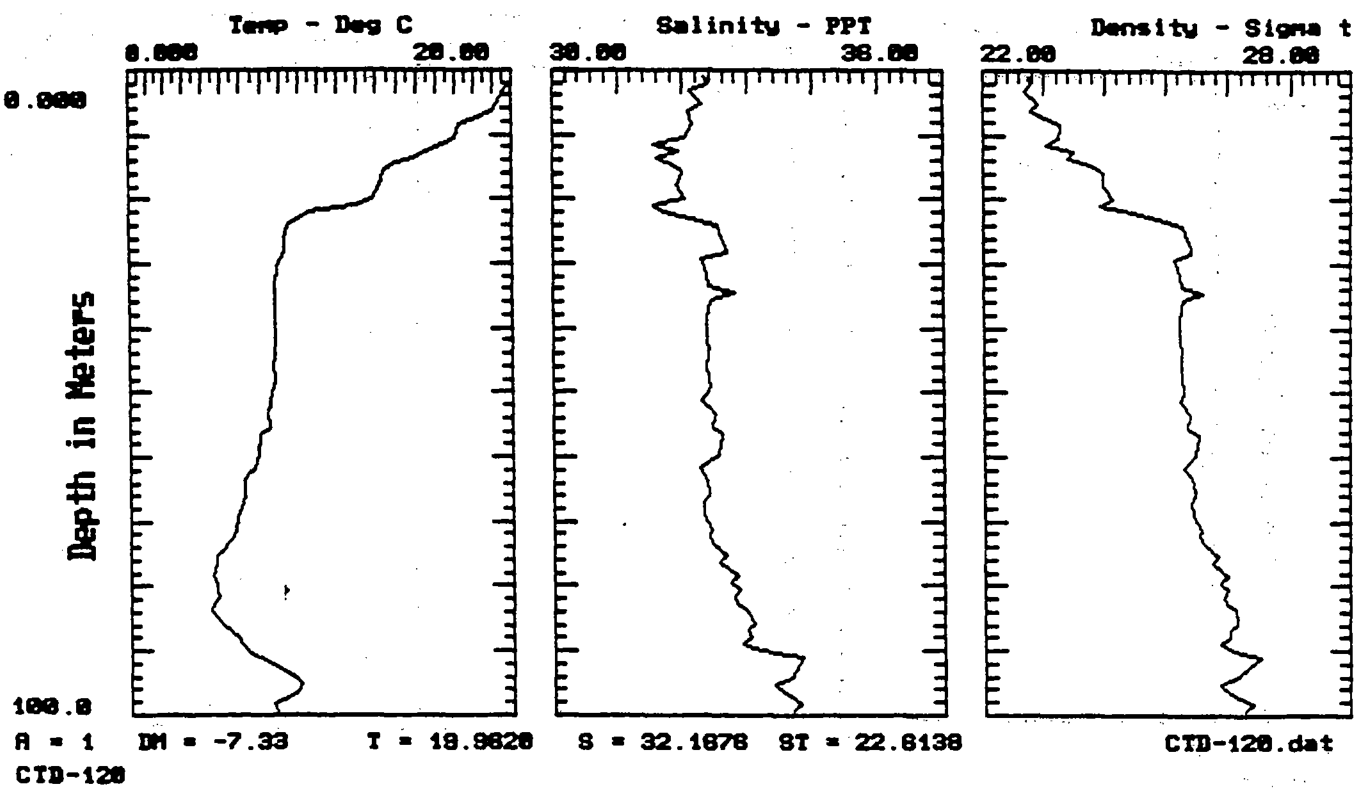

Temp - Deg C
0.000
20.00
Salinity - PPT
32.00
38.00
Density - Sigma t
22.00
28.00
0.000
Depth in Meters
300.0
A = 1
DM = -10.47
T = 17.8824
S = 0.4838
ST = -1.8444
CTD-083.dat
CTD-083 Surface Detail

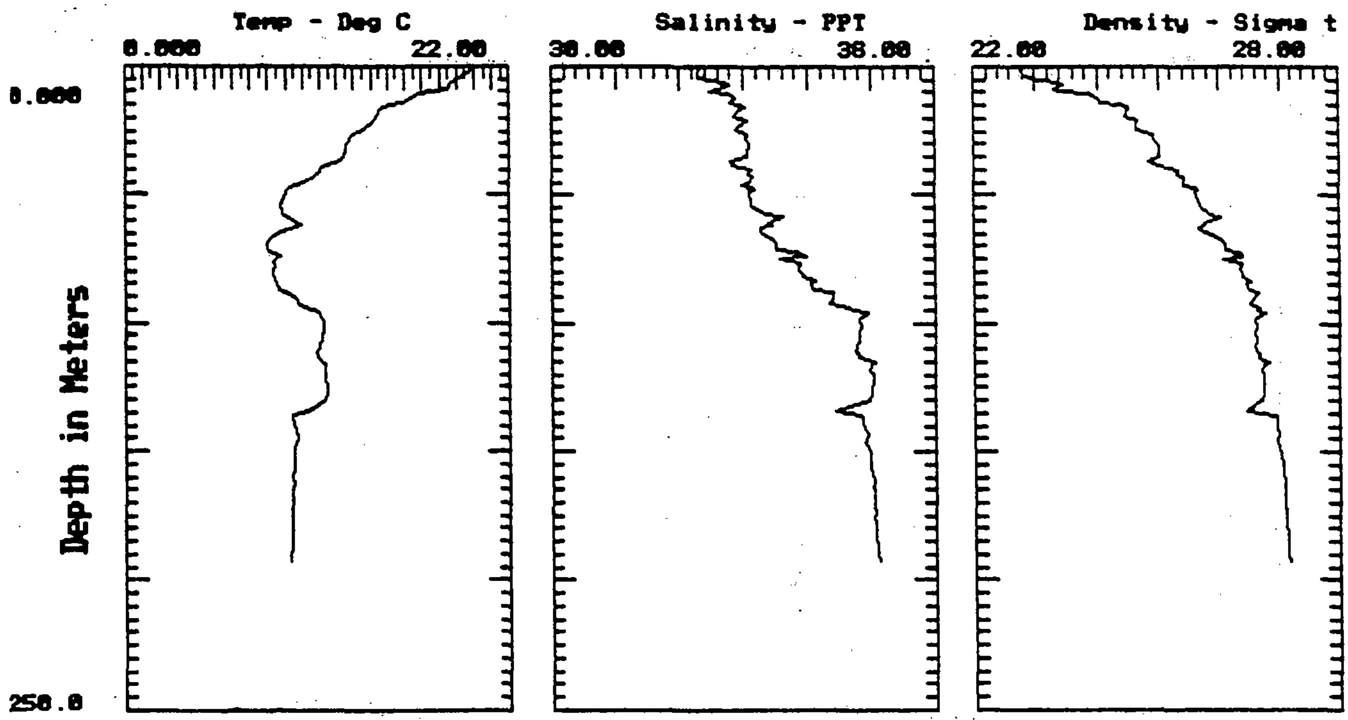

Temp - Deg C
0.000
20.00
Salinity - PPT
30.00
38.00
Density - Sigma t
22.00
28.00
0.000
Depth in Meters
1000
A = 1
DM = -10.47
T = 10.5828
S = 0.4138
ST = -0.8340
CTD-086.dat
CTD-086


Temp - Deg C
0.000
20.00
Salinity - PPT
30.00
38.00
Density - Sigma t
22.00
28.00
0.000
300.0
Depth in Meters
A = 1   DM = -10.47   T = 10.5928   S = 0.4138   ST = -0.8340
CTD-096.dat
CTD-098 Surface Detail


Temp - Deg C
0.000
20.00
Salinity - PPT
30.00
38.00
Density - Sigma t
22.00
28.00
0.000
100.0
Depth in Meters
A = 1   DM = -9.42   T = 10.6495   S = 0.4181   ST = -0.8403
CTD-099.dat
CTD-099

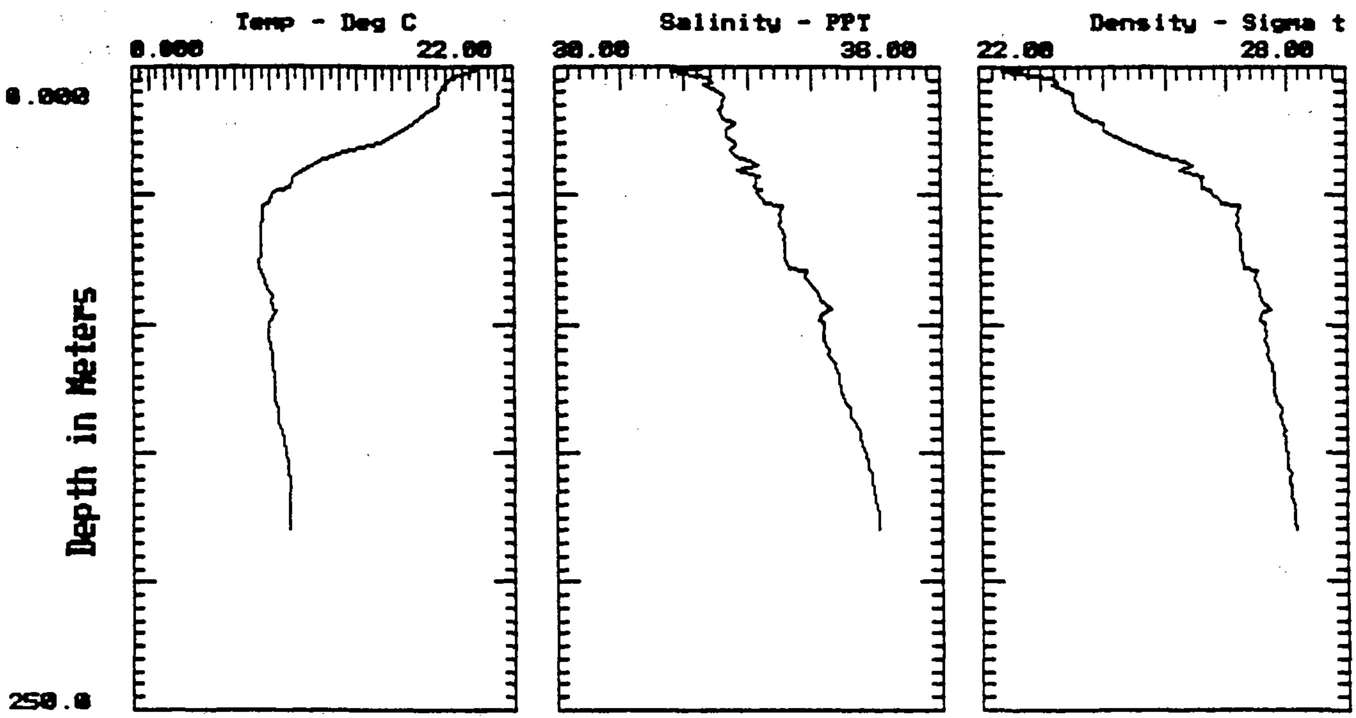

Temp - Deg C
0.000
20.00
Salinity - PPT
30.00
38.00
Density - Sigma t
22.00
28.00
0.000
Depth in Meters
100.0
A = 1
DM = -0.37
T = 20.1415
S = 0.2327
ST = -1.6449
CTD-119.dat
CTD-119


Temp - Deg C
0.000
20.00
Salinity - PPT
30.00
38.00
Density - Sigma t
22.00
28.00
0.000
Depth in Meters
100.0
A = 1
DM = -7.33
T = 18.9820
S = 32.1678
ST = 22.8138
CTD-120.dat
CTD-120



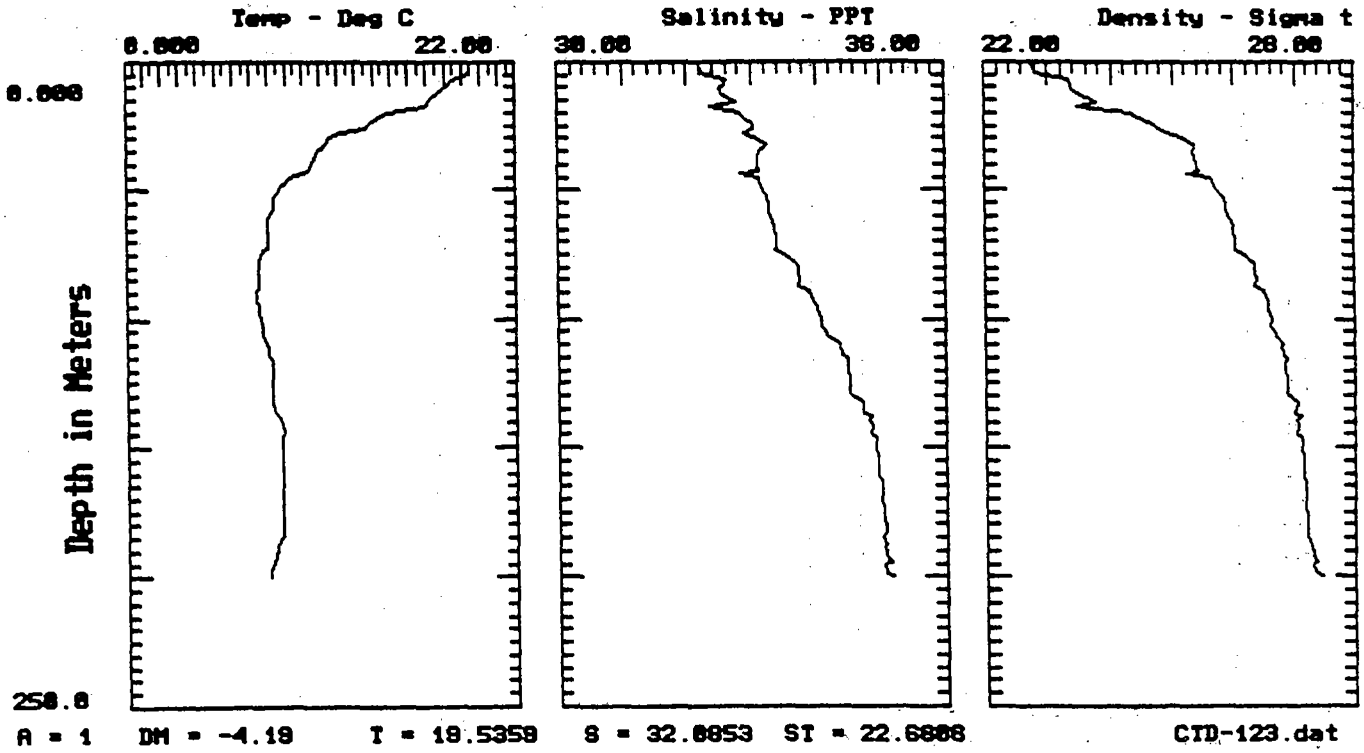
A = 1 DM = -0.37 T = 20.0007 S = 0.4924 ST = -1.4173 CTD-121.dat

CTD-121

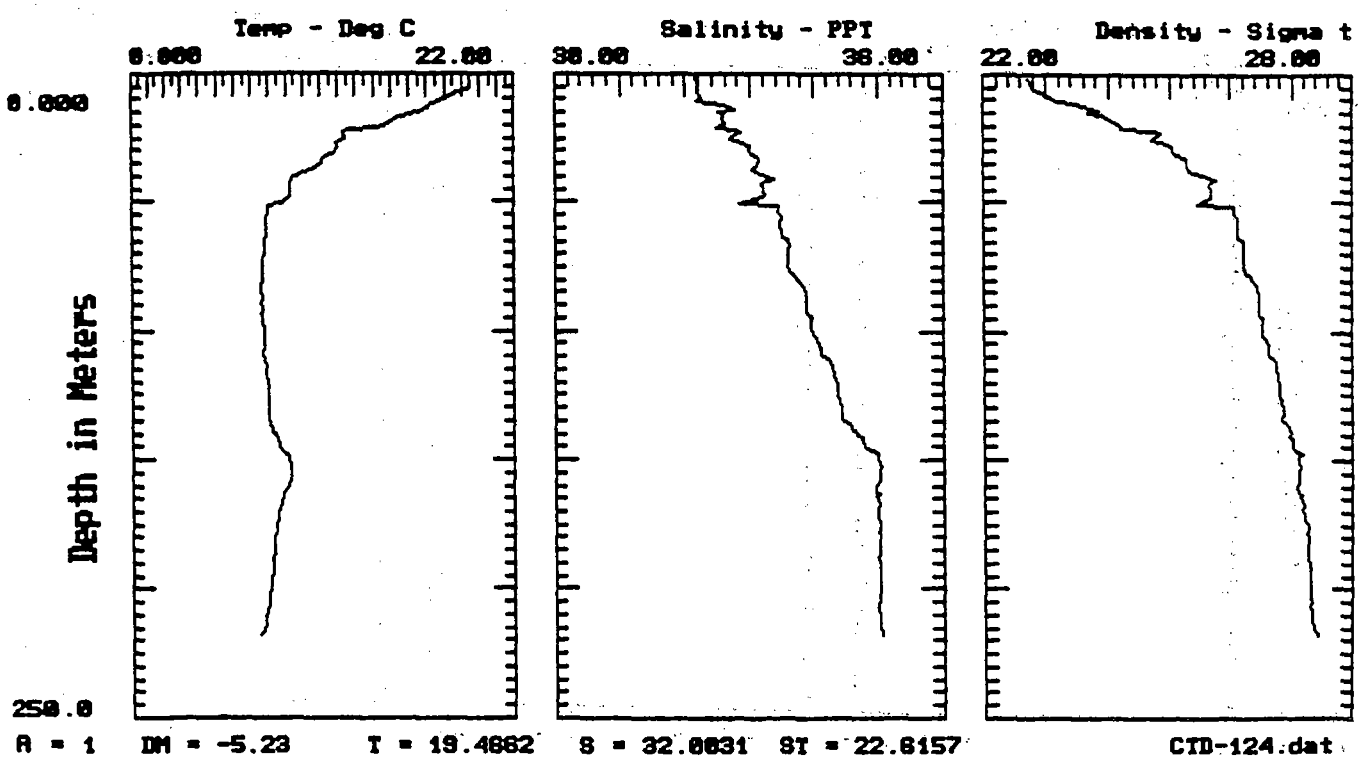


A = 1 DM = -0.00 T = 19.1504 S = 32.4560 ST = 23.0309 CTD-122.dat

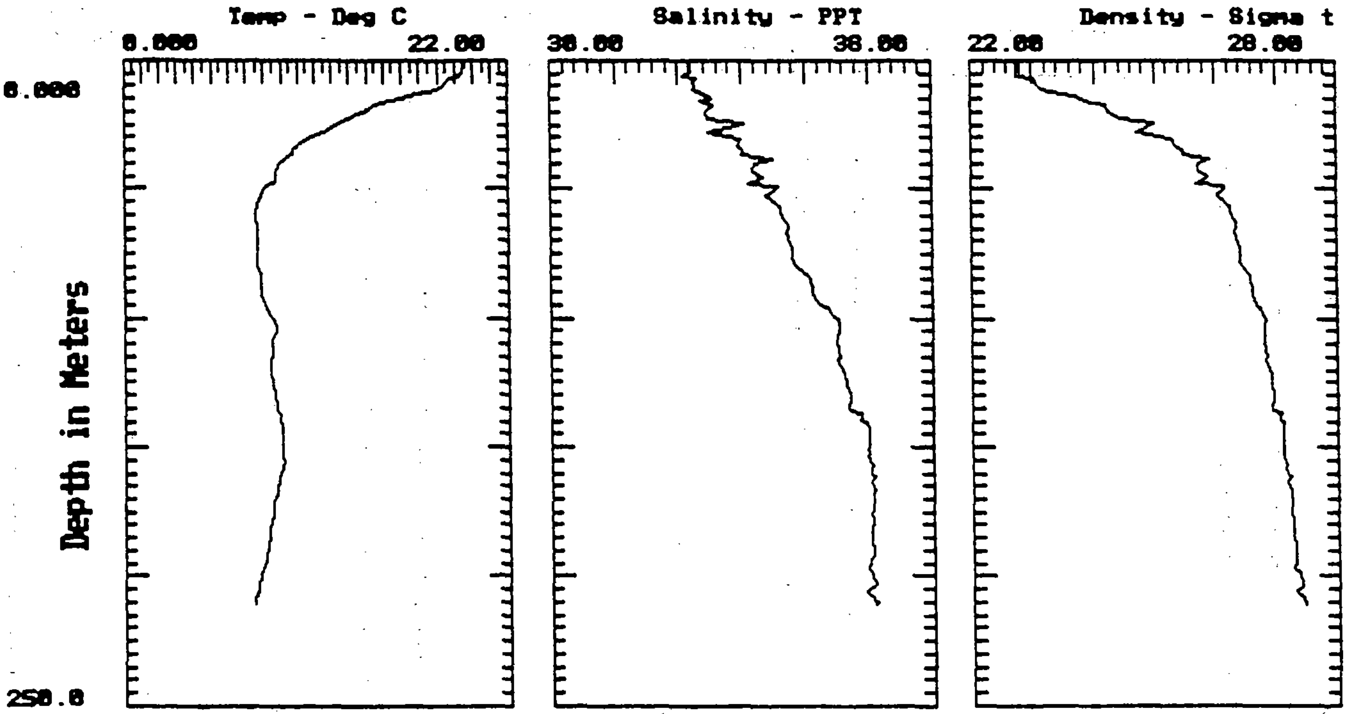
CTD-122



CTD-123

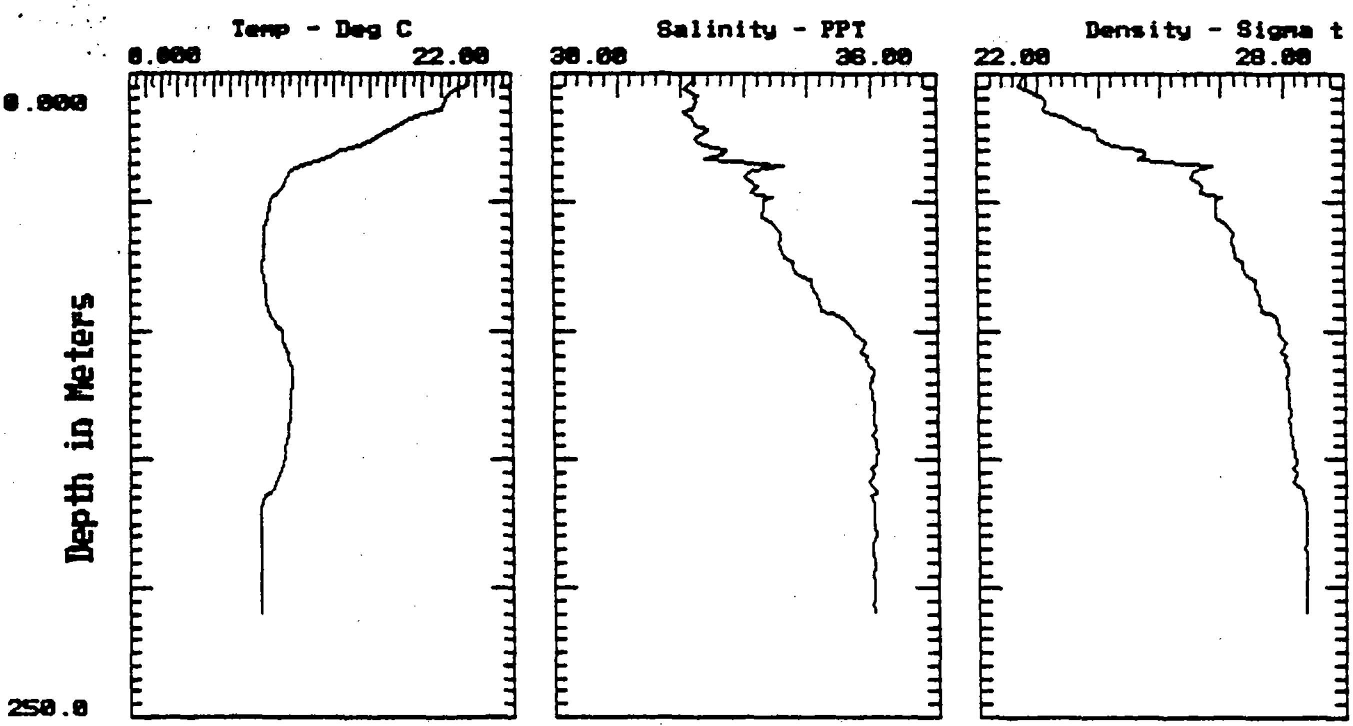


CTD-124



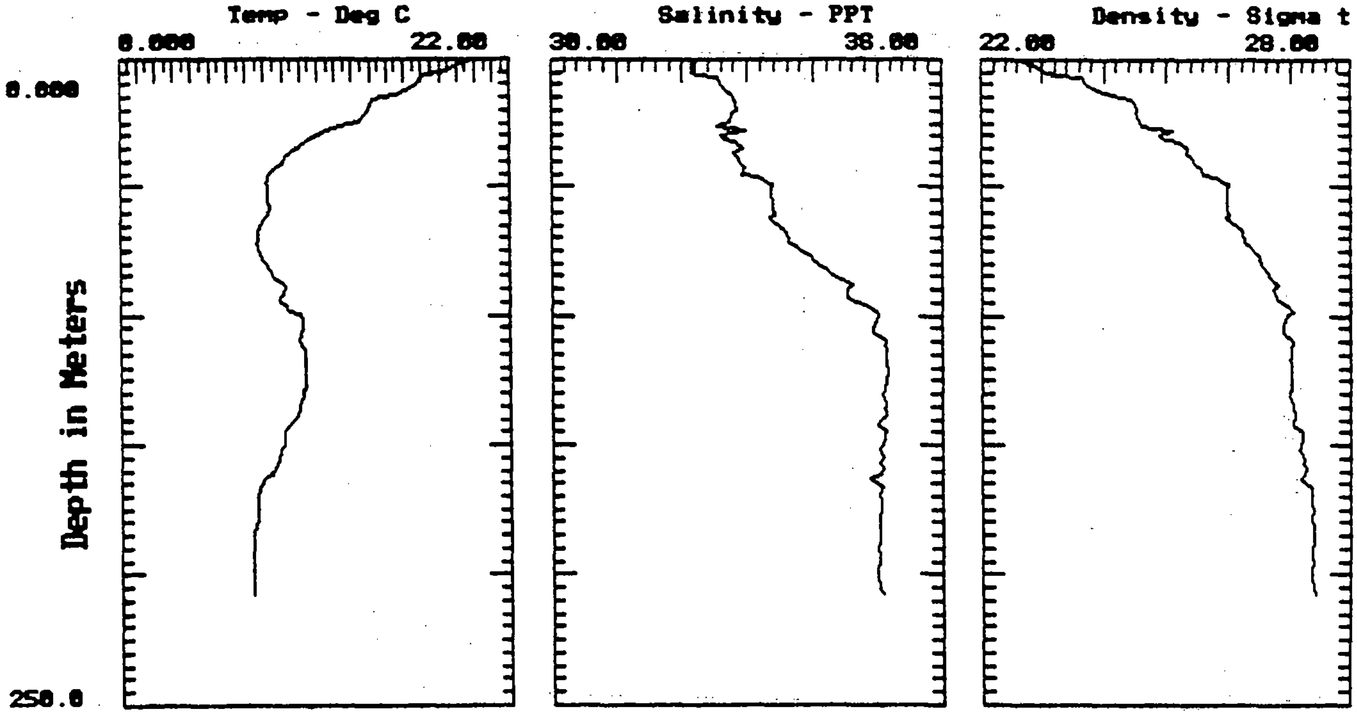
A = 1 DM = -10.47 T = 19.7076 S = 0.9042 ST = -1.0426 CTD-125.dat

CTD-125



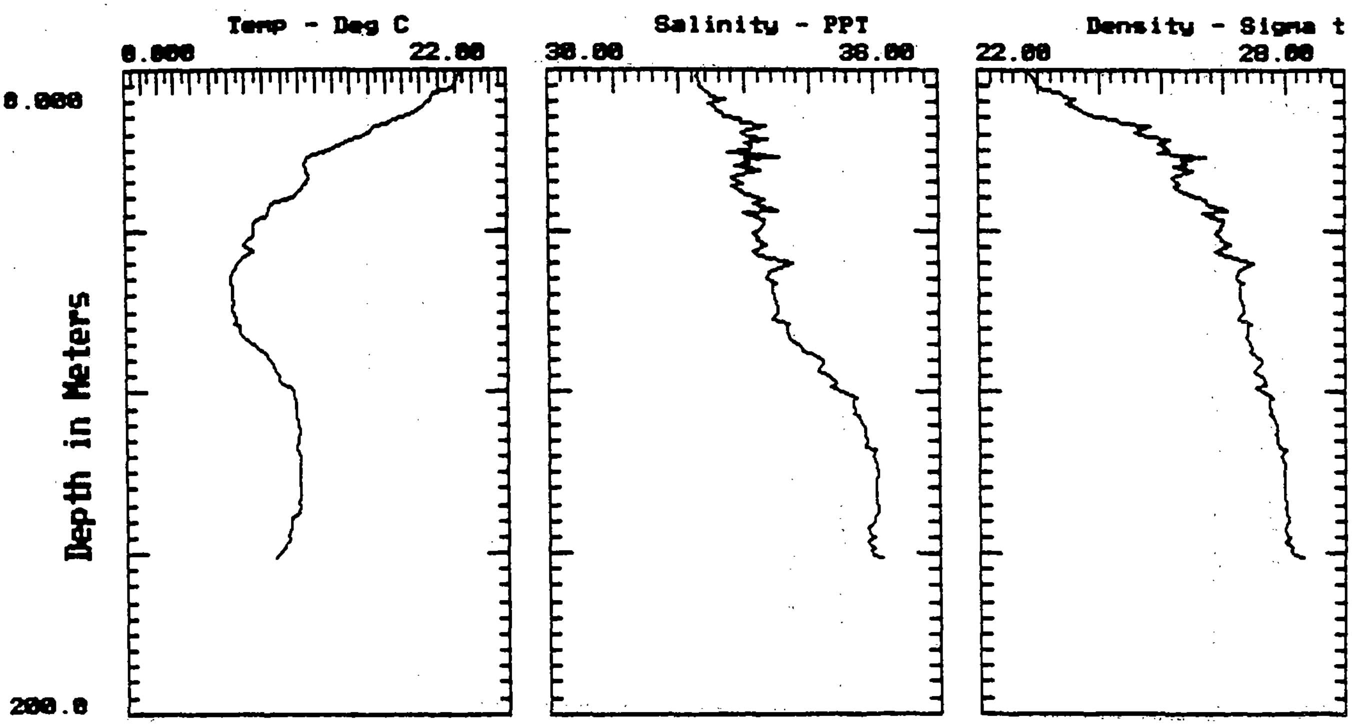
A = 1 DM = -9.42 T = 19.5009 S = 0.0330 ST = -1.6603 CTD-126.dat

CTD-126



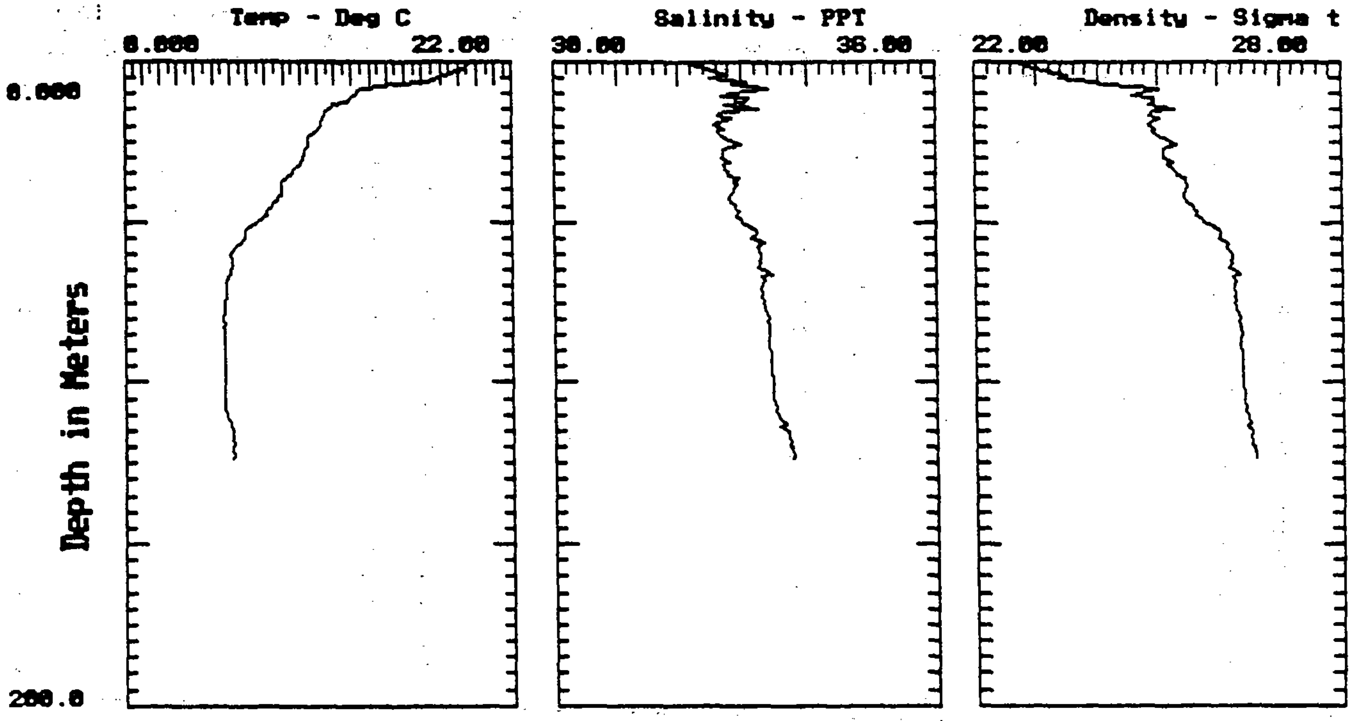
A = 1 DM = -8.14 T = 18.4752 S = 32.0843 ST = 22.6753 CTD-127.dat

CTD-127

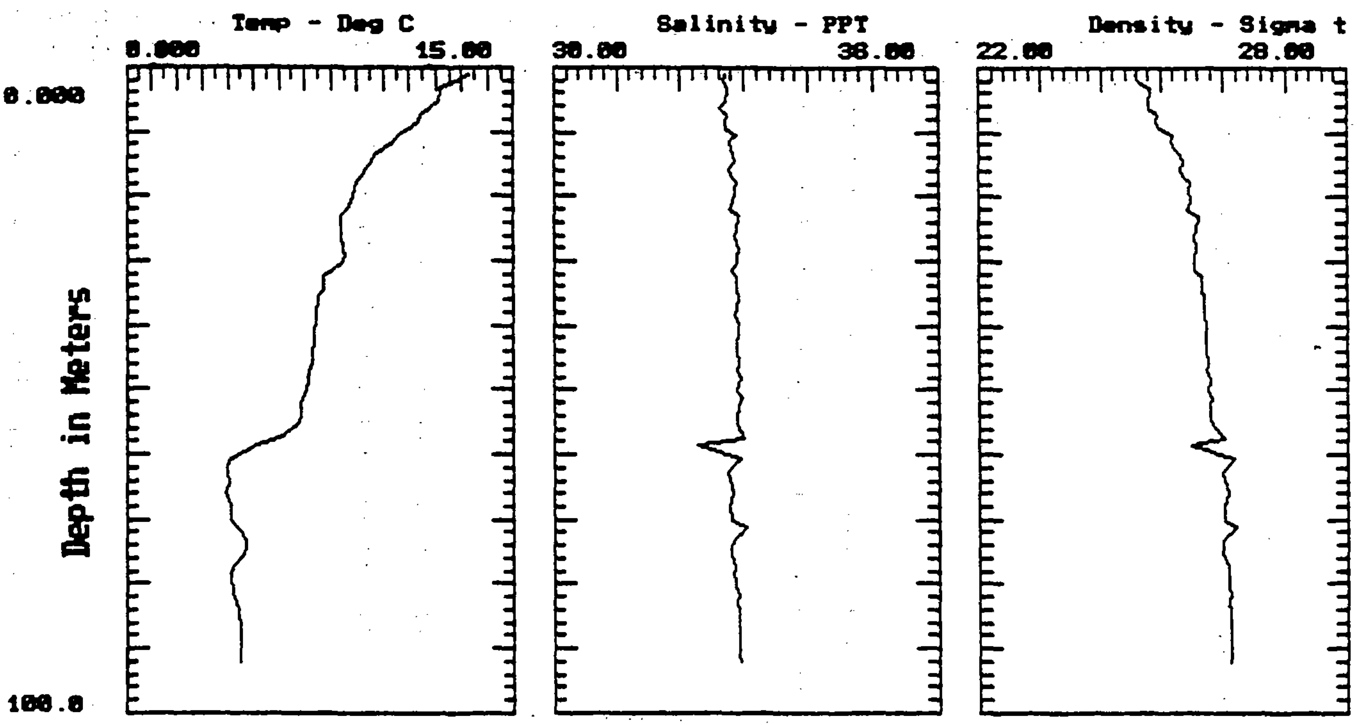


A = 1 DM = -8.42 T = 18.6455 S = 1.0288 ST = -0.9341 CTD-128.dat

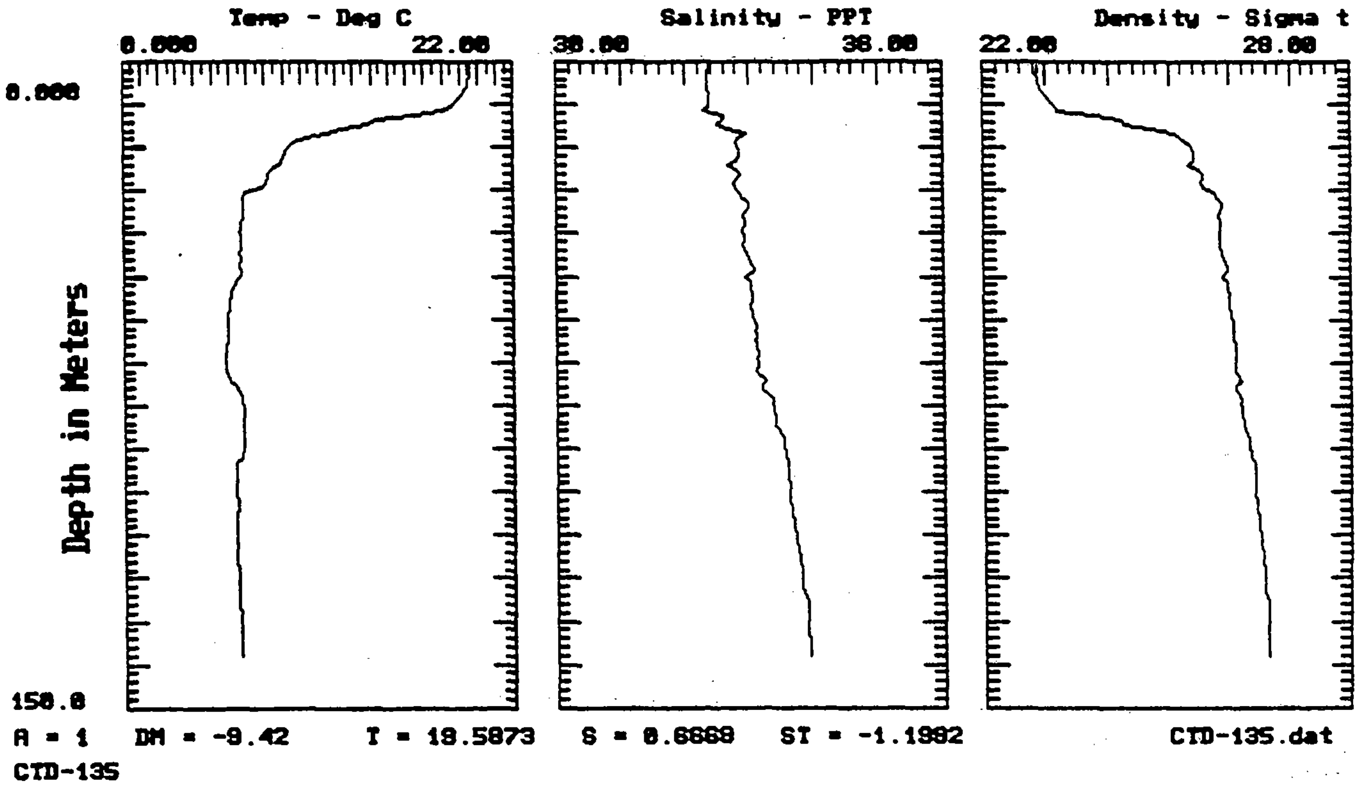
CTD-128

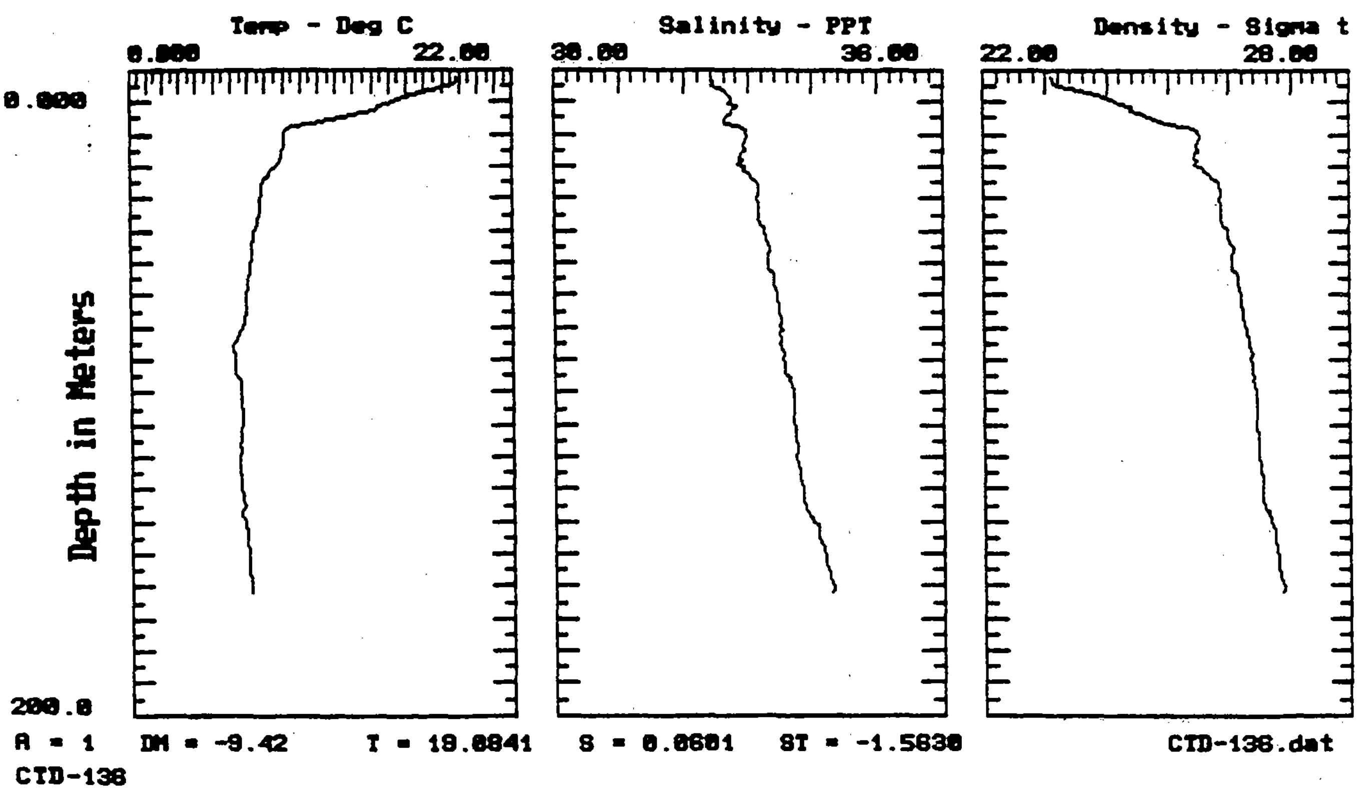


A = 1 DM = -10.47 T = 10.7132 S = 4.4782 ST = 1.0731 CTD-129.dat
CTD-129



A = 1 DM = -10.47 T = 13.7723 S = 1.1139 ST = 0.1425 CTD-133.dat
CTD-133


Temp - Deg C
0.000
22.00
Salinity - PPT
30.00
38.00
Density - Sigma t
22.00
28.00
0.000
Depth in Meters
150.0
A = 1
DM = -9.42
T = 18.5873
S = 0.6669
ST = -1.1992
CTD-135.dat
CTD-135


Temp - Deg C
0.000
22.00
Salinity - PPT
30.00
38.00
Density - Sigma t
22.00
28.00
0.000
Depth in Meters
200.0
A = 1
DM = -9.42
T = 18.8841
S = 0.8681
ST = -1.5838
CTD-136.dat
CTD-136

CRUISE SONGS

FREE TO BE ME, SO THERE!

Michael Loyd

Ain't that Antedon a decad out creature
He's got five of this
He's got five of that
Pentametry is in where' it's at
So ain't that Antedon a decad out creature

Ain't that Antedon a bony creature
He's got calcite there
He's got a skeleton here
If this guy had lips he'd drink milk, not beer
So ain't that Antedon a bony creature

Ain't that Antedon a creepy creature
He's got tube-feet to eat
He's got tube-feet to move
They send mucus cemented balls down pinnuce groves
So ain't that Antedon a creepy creature

So remember this my mates
This thing has got funky traits
Unlike you and me
He's in a world set free
So ain't that Antedon

He says "I'm free yo be me
I don't care so there
I'm one decked out, bony, creepy
Feature creature"

THE TETRAODONITDAE

Rachel Brown

(CHORUS)
Puff, the startled puffer
Doubles his size
Trying to intimidate
Potential predators

His body is elongate
With thick, tough, prickly skin
Most of them do not have scales
Most have no ventral fins

Their skin below is whitish
But not so their backs
The color there is olive-grey
With markings that are black

The puffer we find 'round here
Comes north just past Cape Cod
<u>Sphaeroides maculatus</u>
It's known as the sea squab

They are bottom feeders
Consuming isopods
Also mollusks, worms and crabs
Or shrimps and amphipods

Puffers length will vary
Between one inch and ten
They have small terminal mouths
And all transluscent fins

Spawning time is summer
And around late spring
The eggs are laid, and sink down deep
Attached to anything

The sea squab can be eaten
It's meat is delicious
But tetradotoxin in
Their skin is poisonous

Japan's genus <u>fugu</u>
Cooked by licensed chefs
Puffer poisoning ranks first
In Japan's poison deaths

STANDIN' BOW WATCH

Dave Perkins
Katherine Hewitt

(Chorus)
Sittin' on the bow at night,
I be watchin' for a point of light.
Clippin' my harness on,
And hope I'm relieved by dawn.

I'm just sittin' on the bow of the ship,
Wipin' the fog from my lip.
Sittin' on the bow of the ship,
feelin' fine . . .

I left the mighty helm,
To enter a whole new realm.
Steerin' off into the rain,
Askin' why am I so insane.

Corwith Cramer sails across the sea . . .
Gently rollin' as we set our tired souls free.
Nothin' matters as we aimlessly roam . . .
I'm so glad the sea's my home.

Sittin' here watching the moon rise,
I'll be sittin' 'til the very last star shines.
Countin' the shootin' stars,
And dreamin' 'bout my life so far.

I've met many new found friends,
Yet good-bye will not be the end.
Soon a time will come,
When we'll meet in the evenin' sun.